Biodiversity and Representativeness of Research Natural Areas on National Wildlife Refuges in Montana

Designated Areas Within Benton Lake, Charles M. Russell, Lake Mason, Medicine Lake, and Red Rock Lakes National Wildlife Refuges

FINAL REPORT
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Natural Heritage
Program

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Abstract

There are fifteen Research Natural Areas (RNAs) on National Wildlife Refuges administered by the U.S. Fish and Wildlife Service in Montana. Each was inventoried for significant ecological and botanical attributes: outstanding plant association examples, rare plant associations, and Montana plant species of special concern. Two more study sites with existing or prospective special management designation were also considered in the inventory work. Biodiversity and representativeness information was prepared for each study site, including a profile of all well-developed and uncommon native plant associations, description of any rare plant species populations, and a summary of biodiversity significance that incorporates this new data with original RNA designation records. Related information was compiled to help put results in context for each site, including description of environment, land use, management notes, and recognized non-biological values.

As a result, ten outstanding plant association examples, four rare plant associations, and four Montana plant species of special concern were documented within twelve of the study sites. Most of the study sites are located in the Great Plains, complementing one another and generally representing biodiversity features not otherwise under special management designation in Montana. These include riparian and dune systems, once-widespread grassland plant associations that have been drastically reduced elsewhere and rare grassland plant associations that have not been reported in Montana before, uncommon forest and woodland plant associations, and suites of successional habitats associated with black-tailed prairie dog colonies. Individually and collectively, these RNAs help anchor the conservation of Great Plains natural environments and their component plant associations and species.

We recommend additional surveys that extend beyond current RNA boundaries to identify areas that would fill gaps and achieve representation at scales more consistent with ecological processes and the historic nature of once-widespread vegetation types. The greatest potential for such areas is in the Charles M. Russell NWR and on surrounding public lands, which offer unique opportunities for identification and conservation of representative large-scale landscape systems.

Acknowledgements

The expertise and interest of all USFWS personnel with whom we worked is gratefully acknowledged, along with the project support of the U.S. Fish and Wildlife Service (USFWS) – Upper Missouri/ Yellowstone River Ecosystem Team and the U.S. Fish and Wildlife Service – Ecological Services Office in Helena. We thank Steve Martin of Benton Lake National Wildlife Refuge whose interest and support catalyzed this project. Jim Stutzman - USFWS Montana Wildlife Habitat Office lent initial project support in an agreement between the Montana Partners for Wildlife Program and Montana Natural Heritage Program. Refuge coordination and access were gratiously provided by Mike Rabenberg (Medicine Lake National Wildlife Refuge), Steve Martin (Benton Lake National Wildlife Refuge), Mike Hedrick, Bill Berg, Bill Haglan, Everett Russell, and Matt DeRosier (Charles M. Russell National Wildlife Refuge) and Daniel Gomez (Red Rock Lakes National Wildlife Refuge); with able navigation and assistance provided by skippers Glen Guenther and Jody Jones. The report was reviewed in draft form, and comments and corrections were provided by Steve Martin, Bill Haglan, Tedd Gutzke, Mike Rabenberg, and Jim McCollum.

This work also benefited from the time and skills of Montana Natural Heritage (MTNHP) staff. Jim Vanderhorst provided botanical expertise in field inventory at one site. Scott Lee-Chadde digitized sampling locations and contributed GIS map products. Steve Chadde and Cedron Jones conducted the original work in years prior to this project that set up the databases with RNA information, subsequently used to plan this inventory and provide a framework for compiling new information. The Biological Conservation Database and its linked series of datasets represent the contributions of many MTNHP staff, as well as the work of biologists statewide.

This project was funded under two, separate one-year work order and challenge cost-share agreements between the U. S. Fish and Wildlife Service Program, the U. S. Fish and Wildlife Service – Ecological Services Office in Helena, and the Montana Natural Heritage Program.

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INTRODUCTION

The purpose of this study is to develop a baseline of ecological and botanical information on each Research Natural Area (RNA) within the National Wildlife Refuges administered by the U.S. Fish and Wildlife Service (USFWS) in Montana. The study results provide a reference for refuge managers and researchers, a standard for comparing throughout the Refuge system in the Region, and a contribution to the systematic evaluation of natural areas across the Montana landscape as a whole. This report presents the information on plant associations and rare plants collected at all RNAs over the two years of study, replacing the previous Part 1 report that was submitted as a draft, and which described half of the RNAs.

Plant associations and species that are threatened, endangered and sensitive are central "elements" of biodiversity catalogued by the Montana Natural Heritage Program statewide. The centralized database and computer-assisted inventories focus on the state's rarest animals and plants, as well as high-quality examples of "natural" plant communities. As part of the ongoing operations, we assess the "relative endangerment of species and natural communities" (Genter 1986), a daunting task in eastern Montana with the relative paucity of information on biodiversity features and their location. This was the rationale in proposing an inventory of RNA biological features among National Wildlife Refuges in Montana, emphasizing community types, and also considering threatened, endangered and sensitive plant species. It was designed to contribute to the statewide framework for identifying and filling representative natural areas targets in eastern Montana, to identify the features protected by them, and to increase the potential wildlife management usefulness of existing RNAs for the USFWS while also contributing to the understanding of ecological and botanical resources.

From the early years of wildlife management and the emphasis on regulating mortality and productivity for individual species, the scope has broadened to managing species' habitat, habitat processes, and the fauna and flora at large.
The USFWS adopted an ecosystem approach to fish and wildlife conservation in 1994, defined as "Protecting or restoring the function, structure, and species composition of an ecosystem, recognizing that all components are interrelated" (Martin 1996).

Ecosystem management and sustainability hinge on the maintenance of plant and animal species diversity as well as natural processes, including disturbance (e. g. fire, grazing), succession, and evolution. Biological processes and biodiversity can be defined at a variety of spatial and temporal scales, including genetic, species, population, community, ecosystem, landscape and regional (Noss 1983). Like the "ecosystem management" term, "natural" has acquired numerous potential meanings. A conceptual point of reference in considering "natural conditions" is comparison to the ecosystem's condition prior to European settlement, though this is not readily reconstructed in grassland landscapes, complicated by their dynamic nature at several short- and long-term scales. Using a compendium of historic information (Knowles and Knowles 1993) and current information, preliminary deductions and identification of geographic priorities can be developed. On this basis, some of the National Wildlife Refuges or areas within them offer the last or best vestiges of natural conditions as reference areas for ecosystem management.

Research Natural Areas are critical to ecosystem management in the following ways:

Reference and Monitoring Sites:

The number of examples of natural ecosystems that remain is finite and shrinking as landscapes are altered and degraded (Noss 1987). It is judicious to manage some ecosystems for their existing natural conditions to reduce the risks associated with our limited knowledge of ecosystem functions and to insure ecosystem diversity, health, and sustainability.

Many natural resource management activities can be conceived of as experiments; their outcome, including changes in vegetation, animal populations, soils quality, plant susceptibility to insect and disease vectors, and changes in future productivity are, at best, incompletely understood (Franklin 1992). As such, reference points are needed to evaluate the experiment's success. Regardless of the entity monitored, small mammal demography, breeding bird success, neotropical migrant birds, health of endangered species populations, site productivity, or impacts of road density on ungulate distribution, reference points are essential. The reference or benchmark function is one of the principal merits of RNAs and similar areas for management and environmental analysis. The availability of RNAs as

demography, breeding bird success, neotropical migrant birds, health of endangered species populations, site productivity, or impacts of road density on ungulate distribution, reference points are essential. The reference or benchmark function is one of the principal merits of RNAs and similar areas for management and environmental analysis. The availability of RNAs as sites for pure and applied scientific research is closely linked to their importance as reference and monitoring sites, for which research is nonmanipulative and nondestructive.

Broader Research Applications:

RNAs provide more than a framework to answer refuge or regional management questions. RNAs are available to investigate the functioning of ecosystems and the sustainability of both ecosystem processes and community components. They present an opportunity for studying given ecological processes and the natural range of ecosystem variability. Research Natural Area systems are ideally pristine examples that collectively represent the full range of ecosystem types, and the accompanying range of biota, landform, ecosystems, soils, climate, successional stages, disturbance regimes and other ecological processes (see Ryan et al. 1994 for the Rocky Mountain Region types identified to date and Chadde et al. 1996 for the Intermountain Region). In a similar tone, the Refuge Manual states that "RNAS are intended to represent the full array of North American ecosystems; biological communities, habitats, and phenomena; and geological and hydrological formation and conditions" as part of a larger network for understanding cumulative effects and large-scale changes.

Biodiversity Protection:

One of the stated goals of ecosystem management is the protection of biodiversity. The RNA system functions at the "fine filter" level in harboring populations of rare or localized animals, plants, and plant communities. The RNA system may also serve as core areas of genetic diversity for common plant and animal species and their habitats and as a safety net for little known elements of biological diversity (e.g. soil microflora and fauna, terrestrial and aquatic invertebrates, etc.) and their contribution to ecosystem processes. In this capacity they thus serve as part of the "coarse filter" paradigm for protecting biodiversity (Hunter 1991); all the more critical in fragmented landscapes and patchworks of management objectives.

Research Natural Areas are established consistent with the Objectives Handbook of the National Wildlife Refuge System (USFWS Refuge Manual 8 RM 10; referred to as "Refuge Manual" in the rest of text). Their establishment rests on the Handbook policy that "The Service recognizes the importance of preserving plant and animal communities in a natural state for research purposes." They are categorized according to one or more of the following biological or physical features, consistent with their contribution to ecosystem management:

A. Biological features
   1. An ecological community significantly illustrating characteristics of a physiographic province or a biome.*
   2. A biota of relative stability maintaining itself under prevailing natural conditions, such as a climax community.*
   3. An ecological community significantly illustrating the process of succession and restoration to a climax condition following a naturally caused disruptive change. A habitat supporting a vanishing, rare, or restricted species.*
   4. A seasonal haven for concentrations of native animals or a vantage point for observing concentrated populations such as a constricted migration route.

B. Physical features
   1. Outstanding geological formations or features significantly illustrating geological processes.*
   2. Significant fossil evidence.
   3. Any site containing significant evidence illustrating important scientific discoveries.

*(From: *USFWS Refuge Manual 8 RM 10.7*)

Many of the 15 RNAs were originally designated based on their biological significance as providing ecological communities characteristic of the physiographic area. Others were cited as having significance in providing relict habitat or habitat for restricted species. This study was designed to evaluate all of the 15 RNAs in Montana for their ecological and botanical significance as they relate to five of the criteria in the Refuge Manual (asterisked above).

This contrasts with a field-oriented approach that focuses on plant associations. This "ground up" approach was used in keeping with the plant associations of Bourgeron and Engelking (1995). Plant associations and alliances represent the existing, on-site composition as recognized in the National Vegetation Classification Standard (Federal Geographic Data Committee 1997), rather than a generalized mapping unit. While the new federal standard establishes the upper physiognomic classification levels nationwide, the alliance and plant association (floristic levels) have not been standardized and are in progress. The latter are the levels at which targets are set. Most of the detailed classifications are from western Montana compared to eastern Montana (Pfister et al. 1977, Hansen and Hoffman 1988, Hansen et al. 1995, DeVelice et al. 1995, Cooper et al. 1995). Nevertheless, a synthesis of vegetation research results from eastern Montana and adjoining states and provinces provides a sound framework upon which to build and incorporate the full breadth of Great Plains plant community diversity.

There has not been an interagency synthesis of RNA information since the work by the Federal Committee on Ecological Reserves (1977) at the national level. In addition to all previously-mentioned objectives, this project contributes new and standardized information for incorporation into statewide, regional, and national natural areas efforts and applications.

STUDY AREAS

Eight established research natural areas (RNAs) were inventoried in 1997 and seven were inventoried in 1998, representing all designated RNAs administered by the U.S. Fish and Wildlife Service (USFWS) on the national wildlife refuge (NWR) system in Montana (Figure 1). Together they total 11,756 acres.

The fifteen research natural areas fall within five National Wildlife Refuges (NWRs), including Benton Lake, Charles M. Russell, Lake Mason (administered by Charles M. Russell), Medicine Lake, and Red Rock Lakes National Wildlife Refuges. They are part of the NWR System that includes more than 500 refuges nationwide encompassing over 92 million acres of land and water, supporting a diversity of flora and fauna, and established for many different purposes.

The five National Wildlife Refuges of this study are among the largest NWRs in the state, including most of the NWRs east of the Continental Divide. They were established to protect specific wildlife values, briefly highlighted below. This summary provides a basis for considering the contributions of the RNAs within them to the overarching refuge goals.

Benton Lake NWR was established in 1929 as a "refuge and breeding ground for birds." It is a significant breeding ground and migration stopover for ducks, geese and swans and is a recognized shorebird site of the Western Hemisphere Shorebird Reserve Network. It also harbors colonial nesting bird Species of Special Concern including Franklin's gull, double-crested cormorant, white-faced ibis, black-crowned night-heron, black-necked stilt, common tern, forster's tern and black tern, and upland grassland birds declining elsewhere in their range.

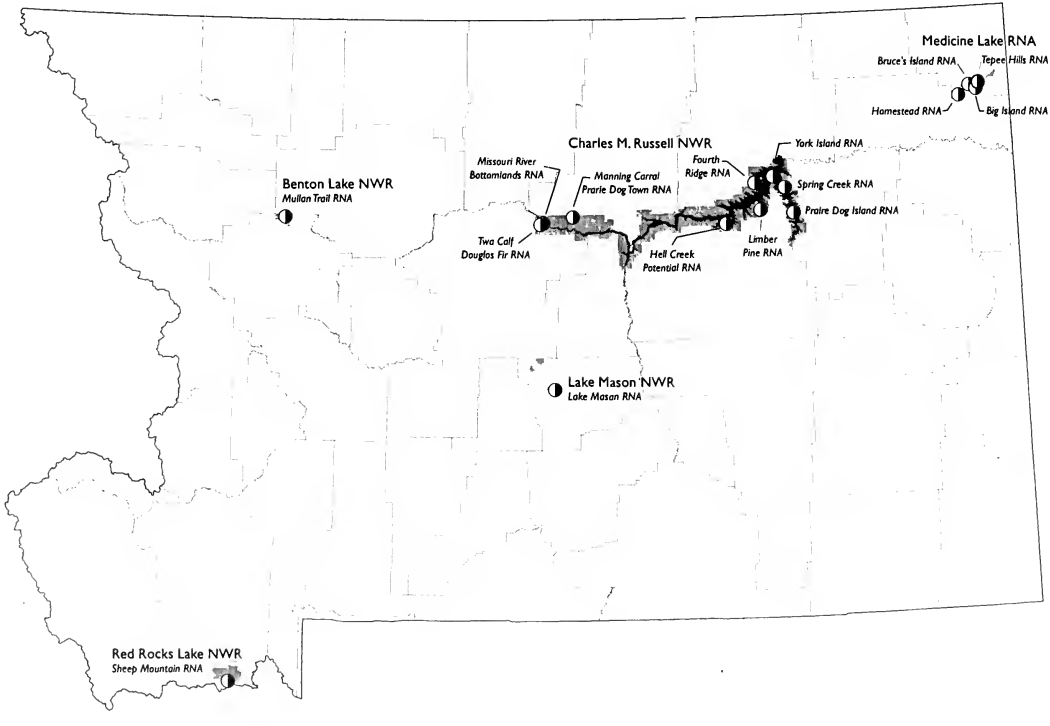
Charles M. Russell NWR was established as a national game range in 1936, later converted to a national wildlife refuge in 1976 in recognition of key game and non-game species occupying its rugged terrain and extensive habitat. They include: pronghorn antelope, white-tailed and mule deer, reintroduced elk, introduced Rocky Mountain bighorn, colonial nesting birds, piping plover, raptors, mountain plovers, black-tailed prairie dogs, upland grassland birds declining elsewhere in their range, and reintroduced black-footed ferret.

Lake Mason NWR was established in 1941 and provides habitat for breeding and migratory waterfowl, shorebirds, passerines, raptors, and antelope.

Medicine Lake NWR was established in 1934 through the passage of the Migratory Bird Hunting Stamp Act, as a "prodigious" waterfowl nesting area for Canada geese, dabblers, and divers. It has been subsequently recognized for its value for colonial nesting birds, as a migration stopover, and as habitat for upland grassland birds, including upland game, that are declining elsewhere in their range.

Red Rock Lakes NWR was established in 1935 through the Migratory Bird Hunting Stamp Act as a major trumpeter swan breeding and wintering area. It has subsequently been recognized for its value for threatened and sensitive raptors, reintroduced peregrine falcons, waterfowl migration stopover, and habitat for lacustrine Arctic graying, Clarke's grebe, black-crowned night-heron, colonial nesting birds, and a host of others.

Figure 1. Locations of US Fish and Wildlife Service-administered Research Natural Areas in Montana



METHODS

Two sets of information were compiled for each RNA site before fieldwork. First, written information was reviewed about the RNAs. This was in the RNA establishment information as available from the U.S. Fish and Wildlife Service. It had previously been collected and entered by Montana Natural Heritage Program in the Biological Conservation Database (BCD) as representing recognized natural areas and public lands (Site Basic Record Database, and Managed Areas Database, respectively.)

Second, U.S.G.S. topographic maps (7.5') and available aerial photos were assembled prior to or in conjunction with fieldwork at each site, and RNA boundaries were copied onto the maps. The photographs were used for site stratification and planning traverses across the major features of the RNA. Mylar overlays were used to map out areas having spectral signatures to consider for ground-truthing, and as base maps for future map production. Often photos were not readily available, so that the topographic maps were used to guide the site traverses, focusing mainly on unique combinations of slope, aspect and elevation throughout the site. In addition, comments were routinely requested from U.S. Fish and Wildlife Service biologists familiar with the RNAs for information on biological features and management, and for information and clarification about access and boundaries. Additional botany and ecology resources were compiled in technical preparation (described separately in methods.)

Field investigations were restricted to established RNA boundaries, with two additions. The Sandhills area of the Medicine Lake NWR was included in surveys because it shares some of the rare plant species features as Big Island RNA, and has a special designation as part of wilderness area. In addition, an area west of Hell Creek State Park was identified by Bill Haglan (Charles M. Russell NWR) as possessing features potentially worthy of considering for RNA designation. We refer to the set of seventeen study sites as including the Medicine Lake Sandhills and Hell Creek areas though they are not designated as RNAs.

Ecological and botanical information collected in the field was used to expand the RNA establishment information, fully described in this report and summarized in BCD. In addition, the individual rare plant records have been entered in BCD, and vegetation plot data is stored in vegetation databases and draft classification documents.

Ecological Methods

Plant communities were identified and documented in terms of their community composition, structure and associated abiotic environmental parameters by establishing representative 1/10 acre plots (37.2 ft radius). Data were recorded on a standardized Community Survey Form as used by Montana Natural Heritage Program consistent with ECADS vegetation ordination analysis (Ecosystem Characterization and Description System, USFS 1996; see Appendix A).

At each RNA, plant associations were documented that met one or more of the four following criteria:

1. Prevailing plant associations within designated areas, i.e., the most extensive vegetation features dominated by native plant species,
2. Plant associations that were the basis of original designation, e.g., the Douglas fir forest at the Two Calf-Douglas-fir RNA,
3. Well-developed plant associations that are potentially rare statewide or rangewide, and
4. Well-developed plant associations in outstanding ecological condition regardless or rarity of extent at the site.

Vegetation sampling plots were placed within each major natural vegetation type based on observed aerial extent of the type. This approach provided documentation for common vegetation types, but was not intended for exhaustive sampling of localized or atypical environments, large replications, or full gradient representation. In some instances, a given common community type may span a range of environments, in which case the attempt was made to sample the modal expression of a community's environmental range. Sampling sites were chosen "subjectively, but without preconceived bias" (Mueller-Dombois and Ellenberg 1974) to meet the criteria of homogeneous vegetation composition, least disturbance, and representative setting. Plot points are mapped on U.S.G.S. topographic maps with 300 feet precision.

On the first Refuge visited, Medicine Lake, excellent quality aerial photography was available at 8 inches / mile that served as a base layer upon which vegetation

Table 1. Target list of Montana plant species of special concern in the study area

SCIENTIFIC NAME *COMMON NAME*	COUNTY	GLOBAL/ STATE RANK[1]	NO. OF OCCURRENCES IN COUNTY(IES) vs IN STATE
Cyperus schweinitzii Schweinitz' Flatsedge	Sheridan	G5 S1	1 / 4
Elodea longivaginata Long Sheath Waterweed	Phillips	G4G5 S1	2 / 4
Lobelia spicata Pale-spiked Lobelia	Sheridan	G5 SH	1 / 2
Mirabilis hirsuta Hairy Four o'clock	Sheridan	G5 S1	1 / 4
Phacelia thermalis Hot Spring Phacelia	Garfield, Phillips	G3G4 S1	2 / 3
Plagiobothrys leptocladus Slender-branched Popcorn-flower	Phillips	G4 S1	1 / 3
Psilocarphus brevissimus Dwarf Woolly-heads	Mussellshell, Phillips	G5 S1	4 / 7
Scirpus heterochaetus Slender spikerush	Sheridan	G5 S1	1 / 1
Solidago sparsiflora Few-flowered Goldenrod	Garfield	G? S1	1 / 2

[1]Species and communities are evaluated and ranked by the Heritage Program on the basis of their global (rangewide) status and their state (statewide) status according to a standardized procedure, using the following set of values and accompanying definnitions.

Rank	Definition
1	Critically imperiled because of extreme rarity (5 or fewer occurrences, or very few remaining individuals) or because of extinction-prone factors.
2	Imperiled because of rarity (6-20 occurrences), or because of other factors making it demonstrably vulnerable to extinction.
3	Vulnerable because of rarity (21-100 occurrences) or found in a restricted range.
4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery.
5	Demonstrably secure, though it may be quite rare in parts of its range.
H	Known only from historic records; possibly extirpated but concerted searches have not been conducted

Table 2. Synonyms among scientific names for dominant graminoids

Common name	Booth (1950), Great Plains Flora Assoc. (1986)	Dorn (1984)	Kartesz (1994)
Western wheatgrass	*Agropyron smithii*	*Elymus smithii*	*Pascopyrum smithii*
Bluebunch wheatgrass	*Agropyron spicatum*	*Elymus spicatus*	*Pseudoroegneria spicata*
Sun sedge	*Carex pensylvanica*	*Carex pensylvanica*	*Carex inops* ssp. *heliophila*
Green needlegrass	*Stipa viridula*	*Stipa viridula*	*Nasella viridula*

In this report, we have cross-referenced each species by both scientific name and common name the first time the species is mentioned under each heading, and by scientific name throughout the remainder of the section. Appendix G is added as a synopsis of common, scientific and six-character acronyms. Common names are based on the list developed by the U.S. Forest Service of Region 1, generally consistent with major floras and the USFWS (Dittberner and Olson 1983).

RESULTS

The fifteen Research Natural Areas and two additional study sites encompass over 50 plant associations, including four that are potentially globally rare. The plant associations provisionally identified as significant representations of globally rare habitats include:

- Douglas fir / littleseed ricegrass forest (*Pseudotsuga menziesii / Oryzopsis micrantha* Forest) on Two Calf – Douglas-fir RNA of C. M. Russell NWR
- Rocky Mountain juniper / Wyoming big sagebrush Shrubland (*Juniperus scopulorum/ Artemisia tridentata* ssp. *wyomingensis* Shrubland on Fourth Ridge RNA of C. M. Russell NWR
- Porcupine needlegrass – thickspike wheatgrass grassland (*Stipa curtiseta – Elymus lanceolatus* Herbaceous Vegetation) on Teepee Hills RNA of Medicine Lake NWR
- Indian ricegrass / lemon scurf-pea barrens (*Oryzopsis hymenoides / Psoralea lanceolata* Sparse Vegetation) on Medicine Lake Sandhills Wilderness area of Medicine Lake NWR

Ten more plant associations are outstanding examples of more common habitats. Each of the state- and globally-significant plant communities are bold-faced in the following table (Table 3. Matrix of plant communities/ associations by Research Natural Area.) This table represents all vegetation sampling conducted in the course of the study for documenting plant community biodiversity significance. Most state- and globally-significant features are highlighted in photographs presented in Appendix C, and all vegetation sampling data is documented in constancy-cover tables in Appendix D.

Two Montana plant species of special concern were documented on the Big Island RNA, including plains phlox (*Phlox andicola*; G5 S2) and hairy four o'clock (*Mirabilis hirsuta* G5 S3). Both species also occur in the Medicine Lake Sandhills, along with two additional rare species, Fendler cat's-eye (*Cryptantha fendleri* ; G4 S1) and Schweinitz' flatsedge (*Cyperus schweinitzii*; G5 S2). Each of these is a widespread species but rare from a state perspective. The Sandhills have the highest number of rare plant species among the study sites. We note that the Big Island and Medicine Lake sandhills field evaluations provided the basis for changing the status of *Mirabilis hirsuta* from a species of special concern to watch. In addition, the known population of hotspring phacelia (*Phacelia thermalis*) was relocated on York Island. The records for the four species that are tracked are presented in Appendix E, and illustrations of them accompanied by descriptions are presented in Appendix F.

This new information was added to prior information in order to characterize each RNA by its primary biological attributes among the RNA criteria in the Refuge Manual. These also include the composite significance of landscape gradients, environmental processes, and biological processes, whether they are separate from or complementing single species and plant association features.

Table 3. Matrix of plant communities / associations by Research Natural Area within Montana's National Wildlife Refuges (arranged alphabetically within lifeform)

Plant Associations /Community Types (arranged by decreasing lifeform stature)	G/S Rank[1]	Research Natural Areas by National Wildlife Refuge (alphabetically arranged)																	
		Benton Lake NWR	Charles M. Russell National Wildlife Refuge									Lake Mason NWR	Medicine Lake NWR					Red Rock Lakes NWR
Forest and Woodland Types		M.T.[2]	F. R.	H. C.	L. P.	M. C.	M. R.	P. D.	S. C.	T. C.	Y. I.	L. M.	Big.I	B. I.	H. S.	M. L.	T. H.	S. M.
Abies lasiocarpa / Juniperus communis	4-5/3																	X[3]
Abies lasiocarpa / Thalictrum occidentale	4/3																	XX
Fraxinus pensylvanica / Prunus virginiana	3?/2-3								X									
Juniperus scopulorum/ Artemisia tridentata ssp. *wyomingensis*	2/2		X								X							
Juniperus scopulorum / Pseudoroegneria spicata	4/4				X													
Pinus flexilis / Pseudoroegneria spicata	4/4																	X
Pinus ponderosa / Carex inops ssp. *heliophila*	3/3						X											
Populus deltoides / Cornus sericeus	4/4						X											
Populus deltoides / Symphoricarpos occidentalis	?/4						XXX											
Pseudotsuga menziesii / Oryzopsis micrantha	2/2									X								
Shrub-dominated Types																		
Artemisia cana / Pascopyrum smithii	4/4						xxxx											
Artemisia tridentata ssp. *wyomingensis / Pascopyrum smithii*	4/3?		XXX						X		X							
Artemisia tridentata ssp. *wyomingensis / Pascopyrum smithii - Nasella viridula*	?/?					X												
Artemisia tridentata ssp. *wyomingensis / Pseudoroegneria spicata*	5Q/5?			X							X							
Atriplex gardneri	3-5/2-3						X											
Atriplex gardneri / Pascopyrum smithii	3/3											X						
Chrysothamnus nauseosus – Eriogonum pauciflorum	?/?				X						X							
Elaeagnus commutata / Stipa comata	?/?															X		
Juniperus horizontalis / Pseudoroegneria spicata	?/?				X				X									
Rhus aromatica / Pseudoroegneria spicata	4/4				X				X									
Sarcobatus vermiculatus – Atriplex gardneri	4/3						XX											
Sarcobatus vermiculatus / Pacopyrum smithii	4/4						XXX					X						
Herb-dominated Types																		
Artemisia longifolia – Oryzopsis hymenoides	2/2									X								
Bouteloua gracilis	4?/?					X[3]												
Bromus tectorum	-							X										
Calamovilfa longifolia - Carex inops	3/3		X		X									X				
Calamovilfa longifolia - Stipa comata	3/?															XX		
Oryzopsis hymenoides / Psoralea lanceolata	2-4/?															X		
Pascopyrum smithii	4/4											XX					X	
Pascopyrum smithii – Bouteloua gracilis – Carex filifolia	?/?					X							X	X			X	
Pascopyrum smithii - Nasella viridula	4/4	XX		X	X							XX						
Pascopyrum smithii - Stipa comata	?/?				X									X				
Pseudoroegneria spicata – Poa secunda	4/4																	X
Puccinellia nuttalliana	?/?		X															
Stipa comata - Bouteloua gracilis - Carex filifolia	?/?				xxx			X	X				X				X	
Stipa curtiseta – Elymus lanceolatus	?/?																X	

1 Refer to the definitions of global and state ranks provided in Table 1

2 RNA abbreviations are: M. T. = Mullen Trail, F. R. = Fourth Ridge, H. C. = Heil Creek, L. P. = Limber Pine, M. C. = Manning Corral, M. R. = Missouri River Bottomlands, P. D. = Prairie Dog Island, S. C. = Spring Creek, T. C. = Two Calf-Douglas-fir, Y. I. = York Island, L. M. = Lake Mason, Big I. = Big Island, H. s. = Homestead, M. L. = Medicine Lake Sandhills, T. H. = Tepee Hills, S. M. = Sheep Mountain

3 Shaded cells indicate exemplary examples of particular plant communities, X's indicate number of plots taken within RNA

The following pages present a summary of all ecological and botanical data collected in the field, in addition to observations and much background information assembled for interpreting results. Background information includes description of environment, land use prior to and subsequent to National Wildlife Refuge establishment, and management comments as preliminary identification of management concerns or questions associated with ecological and botanical features.

This background information is all the more important and difficult to compile in light of the dynamic nature of the Great Plains vegetation, and the absence of precise vegetation information for reconstructing landscape conditions. The references that are made to fire and grazing in the following pages as historically widespread factors that shaped the landscape are based on such works as Higgins (1986) and Umbanhowar (1998) for fire, and on such works as Hanson (1984) and Peden et al. (1974) for bison grazing. This is made in full recognition that there are different theories on how these apply to current landscapes and management practices. One of the common methods for investigating this is through vegetation manipulation experiments with a control. Grazing studies have often used comparative vegetation sampling inside and outside exclosures, as with a recent Rocky Mountain study of grazing affects that included study sites on the Charles M. Russell NWR (Stohlgren et al. 1999). The reader is referred to such works in the management literature, and the management notes that are included in the following pages are rudimentary context for the vegetation data.

The study sites are sequenced alphabetically by refuge name, and alphabetically by RNA name within refuges. Plant associations are described as they occur in each RNA. They are sequenced by relative extensiveness within the RNA, listing the most widespread plant associations first. The classification and characterization of major plant associations is derived from vegetation plot sampling data. The plots provide basic documentation of the existing vegetation, and provided a basis for considering their classification as well as their condition. The plot information regarding species composition is arranged in "synthesis" tables (Appendix D) in the same order of presentation as in the text. "Constancy/cover" tables are also included to convey the variability across a community type. Finally, we note less extensive plant associations and provide qualitative description.

An overall statement of biodiversity significance has been drafted, building on previous RNA information. Other non-biological values are also cited much as they were addressed in the original RNA records.

Benton Lake National Wildlife Refuge

MULLAN TRAIL RESEARCH NATURAL AREA

ENVIRONMENT:
The Mullan Trail RNA is a 392 acre segment of gently rolling terrace and fan landforms associated with Glacial Lake Great Falls. There are no surface drainage features, and it lies within the closed-basin topography surrounding Lake Benton. The limited relief in elevation ranges from 3628 to 3650 ft. Soils have developed from alluvium and lacustrine deposits, made up of fine-textured clays of the Pendroy Series (two map units represented) with slow to moderate rates of runoff. The semi-arid continental climate has peak precipitation in May followed by June (Climate data from Great Falls, Western Regional Climate Center).

VEGETATION:
The vegetation is well-developed and relative uniform, made up a single grassland plant association. The overall visual impression is of homogeneity across the "sea of grass." It is an island of intact natural vegetation, a fragment of a formerly extensive type, now surrounded by agricultural lands and tamegrass.

Pascopyrum smithii – Nasella viridula Herbaceous Vegetation
[PASSMI – NASVIR]
western wheatgrass – green needlegrass grassland

This is the one major plant association present in the RNA. Its composition differs from place to place within the RNA but the two plots established at the far ends of the area evidence a high degree of similarity in both composition and cover by the dominant species. Western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nasella viridula*), prairie junegrass (*Koeleria macrantha*) and narrow-leaved sedge (*Carex stenophylla*) are the dominant graminoids with this component's total canopy cover ranging around 70%. The forb component is low in species, with three that are more common than all others: poverty-weed (*Iva axillaris*), plains bahia (*Picradeniopsis oppositifolia*), and scarlet globemallow (*Sphaeralcea coccinea*). It is possible that forb numbers and flowering levels are suppressed by litter accumulation, but this association as found on heavy soils is intrinsically limited in forb diversity. Patterns of variation from place to place within the area may correspond with land use differences or small-scale natural disturbance such as burrowing animals.

The PASSMI – NASVIR plant association occurs in Montana, North Dakota, South Dakota, Wyoming, Saskatchewan, and southwestern Manitoba. It is ranked G4 by TNC (Schneider et al. 1997). *Nasella viridula* is both more palatable and more sensitive to grazing than *Pascopyrum smithii* and also has a narrower ecological amplitude. In the Yellow Water Triangle area Jorgensen (1979) notes the indicator value of *Nasella viridula* for recognizing sites with a higher soil moisture status, such as swales, toeslopes and moist terraces dominated by silver sage (*Artemisia cana*).

There is a need to refine U.S. and Canadian vegetation classification as it involves this type. Based on a study of relict and near pristine sites, Coupland (1961) identifies a porcupine grass – thickspike wheatgrass grassland (*Stipa curtiseta – Agropyron dasystachyum* Herbaceous Vegetation) as the major grassland type on dark brown and brown soil zones of southern Canada, essentially the prevaling mesic sites in landscape. Coupland notes that south of the 49th parallel the importance value of porcupine grass (*Stipa curtiseta*; includes some or all of what has been treated as *Stipa spartea* in Montana) as determined by cover declines drastically and that *Agropyron dasystachyum* (synonym: *Elymus lanceolatus*) exhibits a gradual decrease as well. *Stipa curtiseta* was noted as dominant elsewhere in the RNA system at Tepee Hills. DeVelice et al. (1995) documented the importance of a PASSMI - NASVIR association across the northern tier of Montana counties. They recognized *Pascopyrum smithii* and *Elymus lanceolatus* as ecological equivalents for site identification and noted the difficulty of field discrimination of these two species based on vegetative or reproductive characters. [Plots NHMTECMT97SC0001, NHMTECMT97SC0002]

OVERALL BIODIVERSITY SIGNIFICANCE:
The Mullan Trail RNA represents a good quality occurrence of what may have been a common if not the prevalent plant association of the Hi-Line (Glaciated Plains Section) of Montana under presettlement conditions. It is a mesic, productive grassland type of the Great Plains biome, and it is estimated that over 90 % of its original pre-settlement extent has been plowed.

While this is not globally rare, few other occurrences are protected and documented on public lands in Montana, and they are smaller or lower quality/condition. The absence of surrounding natural vegetation does constrain options for landscape-scale management if not also its value in having landscape context. Nevertheless, it provides a good rangeland reference and ecological baseline.

The RNA may contribute habitat to previously-documented upland grassland bird Species of Special Concern including Ferruginous Hawk, Burrowing Owl, Loggerhead Shrike and Baird's Sparrow, but does not contain the wetlands that provide primary habitat for the waterfowl and colonial nesting birds found elsewhere on the Refuge. Wildlife values were not evaluated.

OTHER VALUES:
The RNA also preserves a segment of the Old Mullan Trail, part of a 642 mile wagon road linking the western-most navigable waters of the Missouri River at Fort Benton with the eastern-most navigable waters of the Columbia River at Walla Walla, Washington.

LAND USE:
Prior to and after refuge establishment in 1929, the area was grazed as a part of a large common grazing allotment. A summer-fall season grazing permit system was instituted in the 1940s. After the refuge was staffed and facilities developed in the early 1960s, a new grazing management plan provided for a much-reduced level of summer and fall grazing. Although it is not possible to determine the exact grazing regime applied to the RNA, grazing on the whole refuge dropped from about 2,700 animal unit months (AUMs) in 1960 to 1,631 AUMs in 1966. In 1976, livestock grazing was terminated on the refuge, and the area has been rested since that time. The existing composition suggests that is was part of secondary range or more likely a relatively recovered primary range in good condition.

Since the time of RNA establishment, there has been at least one experimental fertilizer application over undefined segments of the area. Refuge records indicate that it did not have the desired effect of increasing productivity or stand structure, and was discontinued. Records do not specify treatment area, application concentrations, or include monitoring.

MANAGEMENT COMMENTS:
Exotic species are uncommon at present. Although both are present, populations of cheatgrass (*Bromus tectorum*) and intermediate wheatgrass (*Agropyron intermedium*) are at low levels within and outside the RNA. The very aggressive yellow sweetclover (*Melilotus officinalis*) and crested wheatgrass (*Agropyon cristatum*) probably pose greater threats in the long term. A narrow band of encroaching crested wheatgrass is found along the road grade disturbance zone along the west boundary of the area.

Historically, fire and bison grazing were two major driving forces in this landscape, responsible for renewing the vigor of the grasses, stimulating forb numbers, and keeping shrub density low. Reintroduction of appropriately timed fire is a management option to consider in containing nearby weed populations and stimulating forbs; realizing that it can help control or increase *Bromus tectorum* and *Melilotus officinalis* depending on conditions.

Charles M. Russell National Wildlife Refuge

FOURTH RIDGE RESEARCH NATURAL AREA

ENVIRONMENT:
The Fourth Ridge RNA spans 1,480 acres representing one among a repeating series of shale ridges at the northeast end of Fort Peck Reservoir. Outcrops of Bearpaw Shale are exposed at the surface. Soils have developed from this parent material and thus are heavy-textured with clays predominating. The shale outcrop landscape is predominantly gently rolling with parts of the landscape prominently erosion-sculpted with pitches and rolls that would be registered only on a large-scale map. The semi-arid continental climate has peak precipitation in June followed by July and May (mean annual precipitation of 11.6 inches; climate data from Fort Peck Power Plant, Western Regional Climate Center, 1956-1997).

VEGETATION:
The vegetation is made up of two extensive upland plant associations that compose a mosaic of shrubland and open woodland. The RNA does not include ponderosa pine (*Pinus ponderosa*) vegetation types as indicated in the establishment report, raising the question of whether boundaries need to be reviewed.

Artemisia tridentata ssp. *wyomingensis* / *Pascopyrum smithii* Shrubland
[ARTTSW / PASSMI]
Wyoming big sagebrush / western wheatgrass shrubland

This is the prevailing vegetation type on Fourth Ridge RNA. Its occurrence is close to defining the northeastern-most distribution of big sagebrush (*Artemisia tridentata*) as a species and as a vegetation type in North America, regardless of subspecies (Shultz 1984). This shrubland occurs on benches and gentle backslopes with fine-textured soils (silty clays to silty clay loam) weathered from shale and claystone. The amount of bare ground and litter is inversely related and highly variable, perhaps depending on past grazing history. The shrub layer is dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*; the Great Plains subspecies) but total canopy cover ranges between 10-20 %, seldom exceeding 25 %, so that according to the National Vegetation Classification Standard (1997) this community is technically grassland with a shrub component. The dominant and diagnostic grass is western wheatgrass (*Pascopyrum smithii*) with subordinate graminoids like threadleaved sedge (*Carex filifolia*), Sandberg's bluegrass (*Poa secunda*), and junegrass (*Koeleria macrantha*) attaining only a fraction of the 40 % plus canopy cover of the dominant graminoid. The highly palatable green needlegrass (*Nasella viridula*) is present in only trace amounts. Forb diversity is low, not surpassing 15 per plot and individual cover values seldom exceed trace amounts; American vetch (*Vicia americana*), white onion (*Allium textile*), bastard toadflax (*Commandra umbellata*), prickly pear (*Opuntia polyacantha*), and yellow sweetclover (*Melilotus officinalis*) have high constancy in the community. *Melilotus officinalis* is uncommon and widely scattered in this type, and may be increasing. [Plots NHMTECFR97SC0001, NHMTECFR97SC0003, NHMTECFR97SC0006]

Juniperus scopulorum /*Artemisia tridentata* ssp. *wyomingensis* Woodland
[JUNSCO / ARTTSW]
Rocky Mountain juniper / Wyoming big sagebrush woodland

Rocky Mountain juniper / Wyoming big sagebrush woodland (*Juniperus scopulorum* / *Artemisia tridentata* ssp. *wyomingensis* Woodland) is an extensive type within this landscape, generally occurring on higher positions with silty clay soils derived from one of the subsidiary shale members of the Bearpaw Shale. JUNSCO / ARTTSW is ranked globally imperiled (G2; Schneider et al. 1997) and is cited to occur only in Montana, Wyoming and Colorado. It is noted to grade most frequently to the ARTTSW / PASSMI community type, which occupies similar positions in the landscape. Sometimes the difference in these communities may reflect past disturbance, such as fire, but the mosaic pattern at Fourth Ridge as it corresponds with gentle dips may indicate edaphic microhabitat differences. The Bearpaw Shale includes mostly non-calcareous members but also has calcareous and bentonitic shale beds.

Juniperus scopulorum is the only tree present, occurring as short-statured and highly branched forms and in a rather clumped distribution. Canopy height ranged from 5-10 ft. At Fourth Ridge, as elsewhere along this area of the Missouri River, its growth form is rounded and generally without a central axis. It is not known if

the peculiar growth form is genetically- or environmentally-induced. Its sporadic distribution challenges accurate estimates of canopy cover, which range from 15-30 %, placing these stands, according to the parameters of the National Vegetation Classification Standard, in both the woodland and grassland categories. The relatively species diverse shrub layer is dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), whose variable canopy cover appears to be a function of competition with neighboring trees. Graminoid and forb cover vary depending on aridity, with western wheatgrass (*Pascopyrum smithii*), prairie junegrass (*Koeleria macrantha*) and yarrow (*Achillea millefolium*) in the widespread, less arid conditions, and little bluestem (*Schizachryium scoparium*), sun sedge (*Carex inops*), and few-flowered wild buckwheat (*Eriogonum pauciflorum*) in driest places.

Puccinellia nuttlalliana Sparse Vegetation
[PUCNUT]
Nuttall's alkaligrass barrens

This association is sparsely-vegetated with Nuttall's alkaligrass (*Puccinnellia nuttallii*) as dominant, occurring as a broken stringer along an intermittent drainage that feeds into Third Coulee. It constitutes the vegetation band closest to the incised channel on a floodplain position with silty loam alluvial soils; salt efflorescence was not observed but this community is known to occur on salt-affected soils that have a slightly wetter, temporarily inundated, moisture regime. Within the TNC tracking system this community type has been reported only from Colorado as G1? but Heidel and Cooper (1996) have documented it from western plains of Montana near the Rocky Mountain Front, noted it in field reconnaissance, and cited it from the Canadian literature (synonym: *Puccinnellia airoides*, Dodd and Coupland 1966).

The Fourth Ridge example of this type has low diversity and is compositionally very similar to other observed Montana occurrences with *Puccinellia nuttalliana* dominant at around 40 % canopy cover; inland saltgrass (*Distichlis spicata*) and povertyweed (*Iva axillaris*) are the only other forbs exhibiting more than trace coverages. This community grades to *Distichilis spicata*-dominated sites on drier positions. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) in trace amounts was the only shrub noted within the plot. Within the channelway, yellow sweetclover (*Melilotus officinalis*) was noted as forming extensive, virtually unbroken swathes in the same position as PUCNUT and extending to the drier *Distichilis stricta* association positions as well.

Downstream from the PUCNUT sampling site a comparable landscape position was occupied by what has been described as western wheatgrass – inland saltgrass grassland (*Pascopyrum smithii – Distichlis spicata* Herbaceous Vegetation; G4; WY, ND). This type has not been formally described from MT, but probably has been subsumed to date within the *Distichilis stricta* or *Pascopyrum smithii* community types of Hansen et al. (1995). [Plot NHMTECFR97SC0004]

Calamovilfa longifolia – Carex inops
Herbaceous Vegetation
[CALLON – CARINO]
prairie sandreed – sun sedge grassland

There are sites occurring as tiny woodland openings at higher positions in the landscape that appear to be developed on a more erosive shale member that weathers to a fissile texture (functions as sandy soil analogue) and may be acidic in its reaction. These sites have a high percent of exposed soil (in excess of 80 %), a much reduced vegetation cover and the composition in dominant vegetation is highly variable across the landscape. They are in erodible settings, which complicates interpretation. The sample plot appears to be most similar in site and vegetation parameters to the prairie sandreed – sun sedge grassland (*Calamovilfa longifolia - Carex inops* Herbaceous Vegetation) that has been identified for southeastern Montana (Hansen and Hoffman 1988).

The vegetative aspect is dominated by rhizomatous graminoids, sun sedge (*Carex inops*) and *Calamovilfa longifolia* (prairie sandreed) with plains reedgrass (*Calamagrostis montanensis*) and *Pascopyrum smithii* just exceeding trace amounts. We hypothesize that an acidic reaction of the substrate is reflected in the forb component dominance by few-flowered buckwheat (*Eriogonum pauciflorum*). Shrubs like prairie rose (*Rosa arkansana*) and trees like Rocky Mountain juniper (*Juniperus scopulorum*) constitute less than 3 % canopy cover and their population structure does not indicate a change in their contribution. [Plot NHMTECFR97SC0005]

OVERALL BIODIVERSITY SIGNIFICANCE:
Fourth Ridge RNA features a woodland community dominated by Rocky Mountain juniper (*Juniperus scopulorum*) in good condition. It is part of one of the most extensive Rocky Mountain juniper woodland stands in the Great Plains portion of the state, and near

the northern limits of its distribution. It also represents *Juniperus scopulorum* as dominant in a low, rounded growth form. It is not known if the peculiar growth form is genetically- or environmentally-induced, i.e, whether the plant association is appropriately recognized as discrete from all others. The rank may be elevated accordingly.

The Wyoming big sagebrush/ western wheatgrass shrubland (*Artemisia tridentata* ssp. *wyomingensis* / *Pascopyrum smithii* Shrubland) is also near its northernmost extent, subject of biogeographic interest, and in notably good condition. The Nuttall's saltgrass barrens (*Puccinnellia nuttalliana* Sparse Vegetation) signifies an under-documented vegetation type of the northern plains. Wildlife values were not evaluated. Overall values are enhanced by the continuity with native vegetation on all upland borders.

LAND USE:
The area is grazed by livestock. The current condition suggests that it is part of secondary range or a grazing regime that maintains good ecological condition. The area lies north of The Pines Recreation Area. Signs of recreational use that were noted include hunter and limited OHV use.

MANAGEMENT COMMENTS:
There are few exotic species in this habitat, with the exception of yellow sweetclover (*Melilotus officinalis*). It is widespread but sparse throughout most of the area, and particularly abundant along the ephemeral watercourses.

There were no signs of fire in the landscape. Fire is lethal to *Juniperus scopulorum* under most conditions, a species that is highly-combustible whether it is dead or alive.

Hell Creek Potential Research Natural Area

ENVIRONMENT:
This area includes rolling uplands at the head of Cold Turkey Coulee but could certainly be expanded to include some of the surrounding highly dissected Missouri Breaks terrain. The climate is essentially Continental (refer to the characterization of the Missouri River Bottomland on the basis of Haxby 18 SW and Roy 24 NE Mobridge, Montana.) All of the landscape is underlain by sedimentary formations. The highest have sandstone caprock and the rest are various shale and mudstone members that weather to fine-textured soil. Thin, carbonate rich lenses occur sporadically.

VEGETATION:
Hell Creek is an area notable for the fact that a relatively recent wildfire has burned much of the upland, rolling portion of the landscape and removed the once-dominant Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). The terrain surrounding the uplands portion is highly dissected and erosive, dropping off into badlands, and supports primarily Pondorsa pine-dominated types, including ponderosa pine / sun sedge (*Pinus ponderosa* / *Carex inops*) and badlands slopes with sparse shrub cover.

Pascopyrum smithii – Nasella viridula
Herbaceous Vegetation
[PASSMI – NASVIR]
western wheatgrass – green needlegrass grassland

Much of the landscape bordering the Missouri Breaks is believed to have been occupied by Wyoming big sagebrush / western wheatgrass – green needlegrass shrubland (*Artemisia tridentata* ssp. *wyomingensis* / *Pascopyrum smithii – Nasella viridula)* that has been burned. This had the result of killing all of the *A. tridentata*, sometimes completely consuming the crown and main stem to ground level, and leaving the landscape dominated by grasses as a seral community. The upland component of this landscape is characterized as gently swelling benches to moderately rolling lands with many different exposures, all of which support this plant association, making it a prevailing type. Soils are derived from fine-grained sedimentary strata (shale?) and are primarily silty clay loams.

The length of time since fire is difficult to determine but most of the landscape that once supported *Artemisia tridentata* ssp. *wyomingensis* as a dominant, as inferred from density of sagebrush skeletons, is only very slowly returning to that status. No *Artemisia tridentata* seedings were found on the plot and only the merest traces of fringed sage (*Artemisia filifolia*) and broom snakeweed (*Gutierrezia sarothrae*) were noted. The grass component strongly dominates this seral phase; western wheatgrass (*Pascopyrum smithii*) is relatively evenly distributed throughout the stand and its cover (currently 40-50%) may still be increasing following the burn (see Hansen and Hoffman 1988 for a comparison of grass production with and without *A. tridentata*). The appreciable cover of green needlegrass (*Nasella viridula*) indicates the relative mesic, productive nature of this site. Threadleaf sedge (*Carex*

filifolia) and bluebunch wheatgrss (*Pseudoroegneria spicata*) are also important grasses in the plot and across the stand. The forb component is diverse but no one species is represented by more than a trace. Of the native forbs, prairie smoke (*Geum triflorum*), shaggy fleabane (*Erigeron pumilis*), scarlet globemallow (*Sphaeralcea coccinea*) and dotted blazing-star (*Liatris punctata*) appeared to the most consistently distributed across the landscape. [Plot NHMTECRN98SC0011]

Artemisia tridentata ssp. *wyomingensis* / *Pseudoroegneria spicata* Shrubland
[ARTTSW / PSESPI]
Wyoming big sagebrush / bluebunch wheatgrass shrubland

The representation of this association is highly dependent on the extent of coarser-textured substrates. Within the Hell Creek area this association is found in small patches confined to the uppermost portions, usually having western or southern exposures, of gentle slopes that are capped with a sandstone member of the local mix of sedimentary strata. Soil texture ranges from fine sandy loam to fine sands.

Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) dominates the shrub layer but its cover is generally not sufficient (20% or less) to place these stands as shrublands in the national classification. Fringed sage (*Artemisa frigida*), yucca (*Yucca glauca*) and fragrant sumac (*Rhus aromatica*) are regularly present with cover usually less than 1 or 2 percent. Within the plot, threadleaf sedge (*Carex filifolia*) rather than bluebunch wheatgrass (*Pseudoroegneria spicata*) is the dominant graminoid, but across the local representation of this type dominance shifts among three graminoids, also including needle-and-thread (*Stipa comata*). This description of the type differs from that of Hansen and Hoffman (1988) for southeastern Montana in which *Pseudoroegneria spicata* is uniquely dominant and may be an artifact of the dissected terrain or it reaching the margins of its distribution. The forb component is shared with the adjacent PASSMI – NASVIR community, with the exception of silver-leaved scurf-pea (*Psoralea argophylla*) a species well known to favor sandy substrates. [Plot NHMTECRN98SC0012]

Other VegetationTypes: Little bluestem (*Schizachyrium scoparium*) is a localized dominant on coarse-textured knolls in the area.

The presence of ponderosa pine (*Pinus ponderosa*) in surrounding lands is taken to represent the *Pinus ponderosa* / *Carex inops* Woodland. In addition, limber pine (*Pinus flexilis*) is known from ridgelines with lenses of calcareos substrates in Hell Creek State Park to the east, and could possibly occur in the potential RNA area.

OVERALL BIODIVERSITY SIGNIFICANCE:
The Hell Creek uplands present a well-developed, moderately extensive example of a productive, widespread plant association of western wheatgrass – green needlegrass grassland (*Pascopyrum smithii – Nasella viridula* Herbaceous Vegetation) in excellent condition. This area lies at the border between gentle plains and Missouri Breaklands, and warrants evaluation for its representation of both segments of the Great Plains biome as well as the landscape gradient. The habitat continuity with all of this surrounding unglaciated terrain contributes to its ecological value.

Small cage exclosures were noted, and it is possible that this area is already being used in studies of fire response or wildlife utilization. If not, it would be worthwhile to compile wildfire history information for use of this otherwise well-suited area as a laboratory for studying natural succession. Wildlife resources were not evaluated.

LAND USE:
The area has been part of a grazing allotment as secondary range. It is not currently grazed. Though it is isolated, it receives use by hunters, if not other visitors.

MANAGEMENT COMMENTS:
The area is notably free of yellow sweetclover (*Melilotus officinalis*). No exotic species management problems were identified, though Japanese brome (*Bromus japonicus*) is present at low levels in all communities across this landscape

Limber Pine Research Natural Area

ENVIRONMENT:
Limber Pine RNA encompasses 1,053 acres representing a cross-section of Missouri River Breaks habitat developed on residual soils weathered from shales and non-calcareous sandstone mainly of the Fox Hill Sandstone. It includes all of a large ravine system incised to a maximum of about 300 feet, fed by small springs, and emptying into the backwaters of Fort Peck Reservoir. Extensive grasslands with scattered outcrops span the upland benches and exposed ravine slopes,

shrub-dominated communities are parts of the ravine, and small, scattered woodlands are characteristic of north-facing ravine slopes and segments of the narrow bottoms. The semi-arid continental climate has peak precipitation in June followed by July and May, and a mean annual precipitation of 11.6 inches (Climate data from Fort Peck Power Plant, Western Regional Climate Center, 1956-1997).

VEGETATION:
Represented on this site are at least three major grassland plant associations and many other types of small size or restricted ravine habitats. They readily sort by topographic position, slope, and aspect; but the highly dissected nature of the setting fosters a complicated vegetation pattern.

Stipa comata – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation
[STICOM – BOUGRA – CARFIL]
needle-and-thread – blue grama – thread-leaved sedge grassland

This grassland association occupies the rolling uplands and upland benches with well-drained soils derived from sandstone; it also occurs on moderate to steep slopes, usually those with a southerly aspect.

This association is consistently dominated by needle-and-thread *(Stipa comata)*. Cover of the major co-dominant species, threadleaved sedge *(Carex filifolia)* and blue grama *(Bouteloua gracilis)*, is highly variable and factors controlling this variation have not been identified. Forbs constitute very little cover in this or the following grassland types scarlet globemallow *(Sphaeralcea coccinea)*, rush skeletonweed *(Lygodesmia juncea)*, and silver scurfpea *(Psoralea argophylla)* are the forbs with greatest cover and constancy. Together with the western wheatgrass – needle-and-thread grassland (*Pascopyrum smithii – Stipa comata* Herbaceous Vegetation), they comprise the great majority of the upland landscape. There was some western wheatgrass (*Pascopyrum smithii)* present in nearly every upland site. While there are characteristically steep gradients from *Pascopyrum smithii*-dominated sites to those dominated by *Stipa comata* in western Montana, these gradients are diffuse in eastern Montana. The break-point coverage between these two associations is placed by Hansen and Hoffman (1988) at the point where dominance (in terms of canopy cover) shifts from one to the other principal species. [Plots NHMTECCR97SC0001, NHMTECCR97SC0002, NHMTECCR97BH0003]

Pascopyrum smithii – Stipa comata Herbaceous Vegetation
[PASSMI – STICOM]
western wheatgrass – needle-and-thread grassland

This is the other major grassland association within the RNA; it occurs on benches, concave topography to swales and is associated with slightly finer-textured soils (silt loams or finer, usually shale-derived) than is STICOM – BOUGRA – CARFIL. It grades to the STICOM – BOUGRA – CARFIL type of drier exposures, coarser textured soils, and under intensive grazing pressure. In more moist positions, such as swales, it grades to the PASSMI – NASVIR association.

Calamovilfa longifolia – Carex inops Herbaceous Vegetation
[CALLON – CARINO]
prairie sandreed – sun sedge grassland

[Plot NHMTECCR97BH0002] This community type constitutes the most extensive vegetation on exposed sandy slopes, though its representation on the RNA has very reduced vegetative cover and much more exposed substrate compared to literature descriptions of the type (Hansen and Hoffman 1988, DeVelice et al. 1995). It borders on the RHUARO / PSESPI and STICOM – BOUGRA – CARFIL associations; often the ecotone between these types is abrupt due to the rhizomatous nature of both Calamovilfa longifolia (prairie sandreed) and Carex inops (sun sedge), both typically forming dense clones. RNA examples of these sites are highly erosive and this may constitute the difference between this type and the adjoining plant associations as well as explain the differences between the Limber Pine RNA expression of the type and those literature descriptions of the type. There are questions as to whether an association should accommodate this much variation in site parameters. Calamovilfa longifolia is typically the site dominant, though shrub cover of golden currant (Ribes aureum) and yucca (Yucca glauca) may rival that of the graminoids.

Rhus aromatica / Pseudoroegneria spicata Shrubland
[RHUARO / PSESPI]
fragrant sumac / bluebunch wheatgrass shrubland

This community is associated with sandy, somewhat unstable soils of the steep-slope ravines, particularly southeast- through southwest-facing exposures. It is

most often found as small stands extending from the brow of the slope (where it grades to STICOM – BOUGRA- CARFIL of benches) to mid-slope and is occasionally weakly represented further downslope. Total vegetation cover is low, seldom exceeding 25-40 % and concomitantly the amount of base soil and rock often exceeds 85 %. We speculate that these sites differ from other associations strongly associated with sandy sites (e.g. CALLON – CARFIL) by having more exposed rock and gravel. Fragrant sumac (*Rhus aromatica*) shares dominance of the shrub layer with yucca (*Yucca glauca*), and their relative proportions shifting with no obvious environmental correlates. The graminoid component is usually dominated by low coverages (not exceeding 25 %) of bluebunch wheatgrass (*Pseudoroegneria spicata*) and considerably lesser amounts of grasses associated with sandy soils like indian ricegrass (*Oryzopsis hymenoides*), little bluestem (*Schizachyrium scoparium*), and prairie sandreed (*Calamovilfa longifolia*). Along with the widespread rangeland forbs such as scarlet gaura (*Gaura coccinia*) and scarlet globemallow (*Sphaeralcea coccinea*), occur species that are restricted to sandy sites like green milkweed (*Asclepias viridiflora*), prairie spiderwort (*Tradescantia occidentalis*) and nodding wild buckwheat (*Eriogonum cernuum*). [Plot NHMTCR97SC0004]

Juniperus scopulorum / Pseudoroegneria spicata Woodland
[JUNSCO / PSESPI]
Rocky Mountain juniper / bluebunch wheatgrass woodland

This woodland occurs in small patches on moderate to steep northwest- to northeast-facing slopes from the bottom of ravine slopes to midslope, with soils derived from sandstone or interbeddings of sandstone and shale/mudstone. Some outcrops test positive for calcium carbonate. Generally more than 70% of the surface is exposed as soil and rock. These slopes are moderately to highly erosive. Short-statured (less than 8-9 ft.) Rocky Mountain juniper (*Juniperus scopulorum*) dominates the tree layer and generally its cover exceeds 50 %, making it difficult to traverse stands. Though representing some of the more mesic habitat in the RNA, these are still stressful sites with depauperate undergrowth. Bluebunch wheatgrass (*Pseudoroegneria spicata*) and field milkvetch (*Astragalus agrestis*) are the only forbs occurring in greater than trace amounts. This association is singular for the occurrence of certain forbs, including false starry Solomon's seal (*Smilacina stellata*), Missouri goldenrod (*Solidago missouriensis*), and harebell (*Campanula rotundifolia*).

There is not a discrete pine woodland type present in the RNA, though pine trees are scattered across the juniper woodland. Ponderosa pine (*Pinus ponderosa*) is widespread, but there are no areas where it is common or dominant, as evaluated in studying aerial photos and visiting areas of highest tree density on foot. All probable locations were considered, such as north-facing slopes that might have calcareous outcrops, attempting to locate the limber pine (*Pinus flexilis*). We found only *P. ponderosa*, though the search was not exhaustive. Finding *P. flexilis* is plausible in light of its presence in the Hell Creek State Park to the west on Fort Peck Reservoir, and the Terry Badlands to the southeast. Its presence here would signify an intermediate location between other outlying stands; however, failure to find it here does not diminish the status of this RNA. [Plot NHMTECCR97SC0003]

Chrysothamnus nauseosus / Eriogonum pauciflorum
Sparse Vegetation
[CHRNAU / ERIPAU]
common rabbitbrush / few-flowered wild buckwheat barrens

This small and localized community occurs on steep, south-facing outcrop slopes at the bottom of the ravine, representing a stressful and unique environment. Soils exhibit salt efflorescence. Slopes show signs of sheet and gullying erosion, with over 90% of the surface made up of exposed soil. A similar vegetation association has been described by Branson et al. (1970) in Valley County and by Vanderhorst et al. (1998) for Carter County; both of their studies indicated acid shales as the determinant of the unusual and depauperate vegetation. The examples from the literature occurred on gently rolling terrain whereas this type was only represented on steep slopes on the RNA. Sites are species poor (<20 species) and total vegetation canopy cover does not exceed 30% with dominance shared by common rabbitbrush (*Chrysothamnus nauseosus*), few-flowered wild buckwheat (*Eriogonum pauciflorum*), and bluebunch wheatgrass (*Pseudoroegneria spicata*).
[Plot NHMTECCR97BH0001] [Plot NHMTECCR97BH0002]

Juniperus horizontalis / Pseudoroegneria spicata Shrubland
[JUNHOR / PSESPI]
creeping juniper / bluebunch wheatgrass shrubland

This plant association has been reported in the Little Missouri River badlands (Jensen et al. 1992) and previously noted in the county in the course of baseline botanical work (Heidel 1994), but it has not previously

been documented in Montana. This type occurs in small patches on the RNA in relatively broken topography in north-facing coulee settings. Creeping juniper (*Juniperus horizontalis*) is documented to occur with bluebunch wheatgrass (*Pseudoroegneria spicata*) and a number of other graminoids such as sun sedge (*Carex inops*) and threadleaved sedge (*Carex filifolia*). *Juniperus horizontalis* is often associated with intrinsically erosive sites and such may be the case here. [Plot NHMTECCR97BH0004]

Pascopyrum smithii – Nasella viridula Herbaceous Vegetation
[PASSMI – NASVIR]
western wheatgrass – green needlegrass grassland

This is a minor type, confined to swales and north-facing slopes, usually on toe-slope positions. Both dominants (also indicators of the type) are strongly preferred forage by cattle and none of the sites had green needlegrass (*Nasella viridula*) cover values even approaching those registered on some sites (within the region) where grazing has been less intensive. Needle-and-thread (*Stipa comata*), threadleaf sedge (*Carex filifolia*) and blue grama (*Bouteloua gracilis*) are poorly represented on these sites

Note: With the incised drainages, considerable topographic relief and some variety of parent materials there are numerous habitats, including some badlands topography, that was not adequately surveyed for community types.

SPECIES:
Montana plant species of special concern were not found. There are common species that might be mistaken for rare species, including green milkweed (*Asclepias viridiflora*) and linear-leaf four o'-clock (*Mirabilis linearis.*) There are a few rare species that were sought unsuccessfully on sandy habitat as found on the south-facing slopes, including little indian breadroot (*Psoralea enneandra*) a species that blooms early in the growing season, and nine-anther dalea (*Dalea enneandra*) which blooms late in the growing season. Review of twinpod (*Physaria* spp.) specimens collected on-site and in herbaria are pending. The widespread species, common twinpod (*Physaria didymocarpa*), has been documented from Garfield County (Booth and Wright 1966). The regional endemic species, double twinpod (*Physaria brassicoides*), has recently been documented from Carter County (Vanderhorst et al 1998).

OVERALL BIODIVERSITY SIGNIFICANCE:

This site is a significant representation of dissected plains and the semi-open ravine systems on the Missouri Breaks, with all the landforms and vegetation typical of the Fox Hills Sandstone. It offers a larger array of xeric ravine habitat and associated vegetation than the Spring Creek RNA, and complements the combination of the Missouri River Bottomlands RNA and the Two Calf – Douglas-fir RNA as a Missouri River Breaks landscape on Bearpaw Shale over 60 miles west.

Though none of the plant associations are rare or unusual at this location in the state, there is a high vegetation and plant species diversity as supported by the broken topography, sheltered north-facing slopes, array of substrates, and seasonal water. As such, it represent a typical Missouri River Breaks gradient.

Wildlife values were not evaluated, though the RNA with its diversity of habitats is presumed to complement the overarching wildlife values of original game preserve and national wildlife refuge establishment. Overall values are enhanced by continuity with native vegetation on all upland borders.

LAND USE:
This landscape has been grazed in the past and the Rocky Mountain Juniper (*Juniperus scopulorum*) is likely to have been cut for fencing. Grazing practices have contributed to the infestation of annual brome grasses like *Bromus japonicus* (Japanese brome) and *B. tectorum* (cheatgrass) which is quite apparent in the western portion of the RNA on the uplands. The area receives at least light hunting use.

MANAGEMENT COMMENTS:
There are almost no noxious weeds, except for Canada thistle (*Cirsium arvense*) at a springhead. Yellow *sweetclover* (*Melilotus officinalis*) is currently restricted to shale slumps in lower ravine slopes, but has the potential to occupy most of the terrain as judging by results from other landscapes. The shores do not have *Tamarix chinensis* (tamarisk). Perhaps the most abundant non-native species are the annual bromes, mentioned previously.

Fire and bison grazing were driving factors with which this landscape evolved. Reintroducing fire as a management tool is an option on the rolling uplands provided that it was planned to favor the natives over the annual brome populations. With continued fence maintenance, this RNA provides a good rangeland reference and ecological baseline.

MANNING CORRAL PRAIRIE DOG TOWN RESEARCH NATURAL AREA

ENVIRONMENT:
Manning Corral Prairie Dog Town Research Natural Area encompasses a flat ridge, essentially a strip of tableland at the edge of breakland topography. It is typical of the Montana Glaciated Plains (Subsection d) of the Northwestern Glaciated Plains Section (331D). Such areas have received Continental glaciation and accompanying deposits of till and drift over what is essentially a planar to gently undulating surface of soils developed from predominantly clay shales and siltstone. There are numerous on-site exposures of glacial drift to indicate this area has been glaciated. It adjoins and is actually mis-mapped within the Missouri River Breaks (Subsection f) of 331D (Nesser et al. 1997); areas that are strongly and deeply dissected terrain. West of the RNA the elevation drops 600 feet to Rock Creek and east of the RNA are the convoluted subdrainages of Seven Mile Creek). There are bedrock outcrops to the immediate west below the tableland to indicate that the overlying glacial deposits are a thin veneer. The climate (nearest station Haxby 18 SW) verges on Continental with cold, dry winters and the peak in precipitation comes in May and June (36% of the year's total).

VEGETATION:
The diversity of communities present corresponds in part with the use patterns of the black-tailed prairie dog (*Cynomys ludovicianus*) colony that died in a 1993 sylvatic plague episode five years earlier. The present landscape is in a state of secondary succession. Three areas were sampled that appeared to have approximately the same environmental parameters but that may represent different successional stages.

The RNA may have supported shrub-dominated communities of Wyoming big agebrush / western wheatgrass – green needlegrass (*Artemisia tridentata* ssp. *wyomingensis* / *Pascopyrum smithii*) with or without a major component of green needlegrass (*Nasella viridula*). However, no traces of sagebrush skeletons were found in the area occupied by the dog town. Normally in these dry environments the woody skeletons can persist scores of years if they are not burned, even if only in dished-out rootcrowns. We did not see evidence that they had decomposed or burned. In glaciated terrain of northcentral Montana, such sagebrush-dominated communities general decline away from broken topography and with well-drained soils. Information from the surroundings was inadequate to examine cause and effect.

Bouteloua gracilis Herbaceous Vegetation
[BOUGRA]
blue grama grassland

Across the formerly occupied prairie dog town is a shortgrass prairie vegetation that covers most of the gentle uplands of the designated area. This prevailing vegetation is dominated by blue grama (*Bouteloua gracilis*) but with discrete patchy islands where most of the individual plants of midgrass-height species are concentrated around individual prairie dog burrows. This community type appears to be developed in the identical setting as the two types described below. It is distinguished from them by the severe reduction of western wheatgrass (*Pascopyrum smithii*) cover, the absence of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), and the major increase of tumblegrass (*Schedonnardus paniculatus*). It is further distinguished by the presence of early succession species like lemon scurf-pea (*Psoralea lanceolata*) and conyza (or horseweed; *Conyza canadensis*).

This association has very low vegetative cover, low levels of litter accumulation, and much of the ground surface made up of exposed gravels. We hypothesized that these conditions were created when prairie dogs occupied the site and the resulting cover removal promoted wind deflation of the soil surface. Thus this site has three times more exposed gravels than the adjacent shrub-dominated site outside of the prairie dog colony, as well as much higher cover of moss and lichens.
[Plot NHMTECRN98SC0017]

Pascopyron smithii - Bouteloua gracilis – Carex filifolia
Herbaceous Vegetation
[PASSMI – BOUGRA - CARFIL)
western wheatgrass – blue grama – threadleaf sedge
grassland

At the fringes of the formerly occupied prairie dog town there is an abrupt transition between a sagebrush-dominated community outside the colony perimeter, and a grass-dominated community within the colony. A pair of adjoining plots were sampled for direct comparison. Graminoids dominate the site; blue grama (*Bouteloua gracilis*) and western wheatgrass (*Pascopyrum smithii*) are the most conspicuous. Trace amounts of shrubs were noted, including Wyoming big sagebrush (*Aremisia tridentata* ssp. *wyomingensis*), but there are no shrub skeletons to indicate that this lifeform previously

dominated the site. There is major overlap with BOUGRA in a grass composition that is often associated with xeric or disturbed conditions, including plains muhly (*Muhlenbergia cuspidata*), Sandberg's bluegrass (*Poa secunda*), and tumblegrass (*Schedonnadus paniculatus*), and the absence of green needlegrass (*Nasella viridula*).

This communitymay represent a transition state between *Bouteloua gracilis* grassland making up the core of the colony and the colony perimeter. The difference between this outer zone and the inner core may reflect shorter occupancy and duration of succession. Alternately, it may represent the greater speed of recovery in this zone. The plot has the same level of gravels exposed at the surface as the preceding, but it does not have the "pedastalling" of wind erosion around the base of each piece of gravel. It is also in a position for speedier recolonization with the growth of rhizomes by *Pascopyrum smithii* from directly adjoining areas. [Plot NHMTECRN98SC0016]

Artemisia tridentata ssp. *wyomingensis* / *Pascopyrum smithii* – *Nasella viridula* Shrubland
[ARTTSW / PASSMI – NASVIR]
Wyoming big sagebrush / western wheatgrass – greeen needlegrass shrubland

This association or the very similar ARTTSW / PASSMI, which lacks green needlegrass (*Nasella viridula*), commonly exist as matrix or large patch types associated with gently rolling benchland. This particular example of the type is a remaining fragment outside of the discrete prairie dog colony, dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and western wheatgrass (*Pascopyrum smithii*). It also has blue grama (*Bouteloua gracilis*) present; the importance of the grass species in this association are nearly the opposite of what was recorded for the preceding association.

The site occurs at 2,980 ft elevation at the head of a draw in a slight swale that may receive additional moisture through snow deposition, ostensibly causing *Nasella viridula* to be present. The herbaceous layer is dominated by *Pascopyron smithii* and has *Nasella viridula* as a subordinate, up to 10% cover. Canopy cover of the grazing-sensitive *Nasella viridula* is highly variable in these communities depending on past grazing intensities and it is used as an indicator species at even reduced cover values. This is a productive shrubland that has less than 50% bare substrate (soil and gravel), the ground cover consisting mostly of litter, basal area, mosses and lichens. Total shrub cover (25%) places this stand at the break point between shrubland and herbaceous vegetation. The subshrubs fringed sage (*Artemisia frigida*) and broom snakeweed (*Gutierrezia sarothrae*) are consistently present in barely greater than trace amounts. The usual complement of forbs including scarlet globemallow (*Sphaeralcea coccinea*), prairie aster (*Aster falcatus*), and fleabane (*Erigeron pumilis*) are present in trace amounts; only field milkvetch (*Astragalus agrestis*) exceeds trace amounts. [Plot NHMTECRN98SC0015]

Other Vegetation Types: Side slopes were not sampled, and the highly dissected terrain overlain by recent fire contributed to a grassland mosaic. Areas of localized dominance by plains muhly (*Muhlenbergia cuspidata*) were noted, along with Ponderosa pine / bluebunch wheatgrass (*Pinus ponderosa* / *Pseudoroegneria* spicata) where pine survived the recent burn.

OVERALL BIODIVERSITY SIGNIFICANCE:
Like the Prairie Dog Island RNA, this site could be used to track plant succession in the wake of prairie dog use, and/or be considered for prairie dog reintroduction. It is the only one of the two sites that has retained a dominance of native species, making it better suited in studying natural succession.

Apart from such natural succession, this RNA does not represent biome features but has the potential. It lies between rolling glaciated plains and south-facing breakland topography. It is the only RNA with intact plant associations on glacial deposits as opposed to lacustrine or aeolian deposits, or unglaciated landscapes.

Mountain plovers were previously documented in the RNA, and the presence of burrowing owls was mentioned in the original establishment record. Wildlife values were not evaluated in this study.

LAND USE:
The history of livestock use is evidenced in the site name, a gathering point for southward cattle drives or to disperse cows going north (Haglan pers. commun.) The site is currently part of a large allotment.

MANAGEMENT COMMENTS:
A fire had burned at the south end within the recent years. It appeared to have originated in the Rock Creek valley, below, burning more of the surrounding slopes than the uplands. There were no noxious weed problems or exotic species invasions noted.

MISSOURI RIVER BOTTOMLANDS RESEARCH NATURAL AREA

Note: Dillon Island and Grand Island were originally recognized as separate research natural areas, but the subsequent establishment of the Missouri River Bottomlands RNA encompassed both islands and their RNA boundaries.

ENVIRONMENT:
Missouri River Bottomlands Research Natural Area encompasses about 9 miles of free-flowing Missouri River and associated valleybottom spanning 5,085 acres, including three large islands. It also represents the downstream end of the Missouri River designated Wild and Scenic by the National Park Service (1976), i.e., the 9 miles at the downstream end of a 149-mile segment. The valleybottom is over ½ mile wide in the area, with many vestiges of intact bottomland vegetation on islands and meandered slivers scattered among homesteads and abandoned cropland, encompassed within the rugged Missouri River valley rising sharply at the valley edges over 600 ft. above the River. The RNA boundaries follow legal descriptions, zigzagging along midslope or at least toeslope positions almost continuously on both sides of the winding valley.

VEGETATION:
The considerable relief, influence of water, and ongoing successional processes accommodate a complexity of vegetation. We have not tried in this case to place the vegetation descriptions that follow by their relative extent because they are nearly all between 5-10% of the total landscape. Collectively, the plant associations of black greasewood (*Sarcobatus vermiculatus*) are probably most extensive because they are prevalent in lower valley slopes, as well as being a major bottomland association. Stands of plains cottonwood (*Populus deltoides*) of various successional stages are relatively well-represented. Apart from the River itself, about half of the RNA is made up of bottomlands, and in each of the Bottomlands (named for the settlers: Hess, Kendall, Knox, LeClair, McNulty), over half of the bottomlands have been plowed. We have not tried to characterize this major, albeit more altered, segment of the landscape.

The studies of Roberts and Sibbernsen (1979), which focused on woodland and forest types, and Mackie (1965), which emphasized rangelands, were the first major efforts at describing and classifying vegetation for portions of the C. M. Russell National Wildlife Refuge, and provide an important frame of reference.

Artemisa cana / Pascopyrum smithii Shrubland
[ARTCAN / PASSMI]
silver sagebrush / western wheatgrass shrubland

Shrub stands dominated by silver sagebrush (*Artemisia cana*) are a recurrent bottomland landscape component, occurring predominantly as small patches, but ranging to large linear patches on river terraces as well as the islands within the Missouri River. These stands typically are developed on flat to very gently rolling riverine and stream terraces, on medium-textured (loam, silt loams, and silt) alluvial deposits. Though this association can include stands with wetland characteristics, as with temporarily flooded hydrological regime and hydric soils, stands of the RNA evidenced at most flooding and the vegetation was not hydrophytic. Perched, or high water tables, may influence the shrub rooting zone for a portion of the year. Litter is the predominant ground cover, usually in excess of 80 % cover, with small patches of bare soil randomly distributed. This type grades to western snowberry (*Symphoricarpos occidentalis*) on moister sites, and Wood's rose (*Rosa woodsii*) or black greasewood (*Sarcobatus vermiculatus*) dominated community, sometimes directly to Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) or *Sarcobatus vermiculatus*-dominated uplands that lack dominance by rhizomatous grasses and have salt affected soils. These stands probably received heavy use by livestock prior to RNA establishment. Most are in relatively good condition but there are portions of these stands with a strong non-native graminoid component.

These *Artemisia cana* stands are like the big sagebrush stands (*Artemisia tridentata)* elsewhere on the CMR Refuge in that the percent shrub cover ranges from mid-20s to lower-30s, the somewhat arbitrary cutoff between shrubland and shrubby herbaceous vegetation. Shrub dominance is almost exclusively contributed by 3-4 [5] feet tall *Artemisia cana*. Common rabbitbrush (*Chrysothamnus nauseosus*), black greasewood (*Sarcobatus vermiculatus*), and western snowberry (*Symphoricarpos occidentalis*) are nearly 100% constant, but present in greater than trace amounts only at ecotones to surrounding vegetation types. The graminoid component is also consistent in composition with western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nasella viridula*), and *Poa juncifolia* (alkali bluegrass). Despite sample stands being chosen for appearing among the least disturbed, all stands have some measure of non-native grasses including

Kentucky bluegrass (*Poa pratensis*), Japanese brome (*Bromus japonicus*), and on occasion, intermediate wheatgrass (*Agropyron intermedium*). Areas with abundant weed populations have very little *Nasella viridula*, indicating it may be susceptible to grazing and competitive effects. The forb component is sparse and species poor; only the non-native increasers yellow sweetclover (*Melilotus officinalis*), white sweetclover (*Melilotus alba*), and goat's beard (*Tragopogon dubius*) occur in greater than trace amounts. Yarrow (*Achillea millifolium*) is the only native with greater than 50% constancy.

Atriplex gardneri Dwarf Shrubland
[ATRGAR]
Gardner's saltsage dwarf shrubland

This plant association is found along the valley slopes as small patches in a complex mosaic of other sparse vegetation that is more widespread. Surrounding vegetation includes stands dominated by black greasewood (*Sarcobatus vermiculatus*) and Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). Our sample plot differed from these types only in having but a trace of *Sarcobatus vermiculatus* but clearly there is a continuum in substrate properties that is reflected to some degree in the vegetation mosaic. It should also be noted that in the course of reconnaissance Gardner's saltsage (*Atriplex gardneri*) was found to occur with coverages greater and less than 10% (the sparse cover cutoff) which would give some of these stands a sparse cover designation. Overall the cover is greater than 10% giving stands an aspect closer to the type as described for southeastern Montana (Vanderhorst et al. 1998). Within the RNA, ARTGAR occurs both on slope aprons, where alkali-laden fine-textured slopewash accumulates, as well as on slope shoulders and narrow crests and even mid-slope positions of any aspect; virtually anywhere bentonite lenses or unusual shale substrates are exposed.

The vegetation is close to being a monospecific layer of the dwarf-shrub *Atriplex gardneri*, its cover ranging from 5 to 30 (40)%. Depauperate specimens of black greasewood (*Sarcobatus vermiculatus*) generally constitute the only other shrub present. Bottlebrush squirreltail (*Sitanion hystrix*), indian ricegrass (*Oryzopsis hymenoides*) and thick-spike wheatgrass (*Elymus lanceolatus*) are the graminoids most often found here, but not greater than trace amounts. Tall seablite (*Suaeda moquinii*) and plains bahia (*Picradeniopsis oppositifolia*) are the only recurrent forbs in this community.

Populus deltoides / Symphoricarpos occidentalis Floodplain Woodland
[POPDEL / SYMOCC]
plains cottonwood / western snowberry floodplain woodland

Floodplain woodlands are areally extensive communities as broken bands along the Missouri River on the older portion of alluvial bars and outer edges of the river's floodplain; see Hansen et al. (1995) for a discussion of riverine geomorphology explaining the genesis of these stands. Some of the stands representing this community type are flooded virtually every year or at least heavily influenced by the seasonally fluctuating watertable; other stands are more removed, do not experience yearly flooding and their roots are less watertable influenced. During reconnaissance, all degrees of anthroprogenic modification were noted including plowing, seeding to alien species, cutting, domestic stock grazing and browsing in this type. Some stands of plains cottonwood (*Populus deltoides*) had nothing more than combinations of quackgrass (*Agropyron repens*), smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), leafy spurge (*Euphorbia esula*), and American licorice (*Glycyrrhiza lepidota*) in the understory. Stands were sampled that appeared least disturbed, but that is not to say they were undisturbed.

Hansen et al. (1995) interpret this community as both a mid-seral stage of floodplain development and a browsing-induced disclimax (by whitetail deer?) of the plains cottonwood/ redosier dogwood forest (*Populus deltoides / Cornus sericeus* Forest). If that were the case, then animal scouring of these stands is phenomenally thorough because our inventory was able to find no more than one stem of *Cornus sericeus* in the RNA. The common chokecherry (*Prunus virginiana*) and western serviceberry (*Amelanchier alnifolia*) were also scarce. In younger or more mesic representations of this type, canopy cover of the *Populus deltoides* may exceed the 60% crown cover limit for woodlands. The three sampled stands of this type are relatively mature to "old growth" with average diameters of 16-20 inches in two stands and the third with 34-44 inch stems remaining and number of downed and dying veterans. Rotten heartwood precluded obtaining ages on these stems. The mortality in the stand with trees of the largest diameter has resulted in less than 30% tree canopy cover and with no *Populus deltoides* reproduction because of no fresh alluvium being deposited. This stand will is likely to become a *Symphoricarpos occidentalis*-dominated shrubland. Woods rose (*Rosa woodsii*) is the second leading shrub species followed

distantly by species of gooseberry (*Ribes* spp.) and willow (*Salix* spp), which are seldom present with greater than 5% cover. In the better condition stands, western wheatgrass (*Pacopyrum smithii*) and green needlegrass (*Nasella viridula*) are the dominant graminoids and their cover approachs 30%. Commonly, alien graminods such as smooth brome (*Bromus inermis*), quackgrass (*Aropyron repens*), intermediate wheatgrass (*Agropyron intermedium*), and Kentucky bluegrass (*Poa pratensis*) dominate this component. In the sample stands, the forb compoent is minor; the only time a significant forb presence was noted was in the case of exotic species such as Canada thistle (*Cirsium arvense*), yellow sweet clover (*Melilotus officinalis*), and black medic (*Medicago lupulina*). Canada goldenrod (*Solidago canadensis*) was the only native forb occurring in more than half the study plots.
[Plots NHMTECRN98SC0018, NHMTECRN98SC0026, NHMTECRN98SC0030]

Sarcobatus vermiculatus / Atriplex gardneri Intermittently Flooded Shrubland
[SARVER / ATRGAR]
greasewood / Gardner's saltsage intermittently flooded shrubland

This association, or one affiliated to it in name, has previously been identified only from the southeastern and Bighorn Basin regions of Montana and adjoining lands in Wyoming. It has been characterized as a small to large feature occurring on alkali-affected alluvial flats, thus the title of intermittently flooded shrubland. More recently this same type has been noted in Carter County to occur on badland formations (Vanderhorst et al. 1998). The two plots representing this association on the RNA occur on dissected, Bear Paw Shale uplands, bentonite inclusions, and slope aprons with rill, gully and sheet erosion and with plant pedicelling. Ground cover is a monotonous expanse of grayish-tan exposed clayey substrate lacking soil development and with traces of gravel. The vegetative physiognomy of these plots does not technically qualify as shrubland but rather as dwarf shrublands verging on sparse vegetation (<10% total canopy cover). It may be advisable to change the modifier name of the type because even the intermittent flooding is inferred and may not if fact be a significant ecological driver. This type is extensive and recurrent along the Missouri River valley, with so much exposed valley slope. Part of this landscape mosaic supports patches of Gardner's saltsage (*Atriplex gardneri*) or rillscale (*A. suckleyi*) alone, without *Sarcobatus vermiculatus*. These species may define two different associations in the provisional statewide classification, but do not necessarily represent two distinctly-different environments.

Dominance in the shrub canopy shifts between *Atriplex gardneri* and *Sarcobatus vermiculatus* but their cover, singly or combined, does not exceed 15-20%. Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) is present in trace amounts. The graminoid layer is depauperate to nonexistent and the forb component usually follows suit, except for the sporadic, unexplainedly high coverages of rillscale (*Atriplex suckleyi*). Tall seablite (*Suaeda moquinii*) is consistently present in trace amounts. [Plots NHMTECRN98SC0023, NHMTECRN98SC0029]

Sarcobatus vermiculatus / Pascopyrum smithii Shrubland
[SARVER / PASSMI]
greasewood / western wheatgrass shrubland

This community is predominantly a large patch type that develops on the heavy silt to clay loam soils of alluvial fans, toeslope or slope apron positions and old river terraces on nearly level terrain with at most 2-3% slope. Many of these stands receive considerable slopewash including entrained fines from the adjacent erosive uplands. It differs markedly from the previously described black greasewood (*Sarcobatus vermiculatus*)-type immediately above in that it is sufficiently productive that litter forms and accumulates leaving little exposed soil. Most often this type is noted to grade to the *Artemisia cana / Pascopyrum smithii* (silver sagebrush / western wheatgrass) association, that occurs on less salt-affected positions. Together with the *Artemisia cana* shrubland, it is an integral component of the riparian mosaic in this landscape, though none of the representations inventoried on the RNA met the requirements for a jurisdictional wetland.

The shrub canopy is dominated by *Sarcobatus vermiculatus*, usually in excess of 25% canopy cover. Both silver sagebrush (*Artemisia cana*) and rubber rabbbitbrush (*Chrysothamnus nauseosus*) are consistently present, their cover seldom exceeding 10%. The three plots represented sites inferred to be in good condition by their high cover values (>60%) for the dominant grass, western wheatgrass (*Pascopyrum smithii*). Other high constancy graminoids are alkali bluegrass (*Poa juncifolia*), green needlegrass (*Nasella viridula*) and the annual weed Japanese brome (*Bromus japonicus*); the combined cover of native graminoids apart from *Pascopyrum smithii* usually does not exceed 10-15%. The forb composition reflects past disturbance with a variable assemblage of weedy, increaser species present, but their coverages usually

don't exceed trace amounts. Stands and stand segments were noted where *Poa secunda* (Sandberg's bluegrass) was dominant in place of, or in addition to, *Pascopyrum smithii*, a feature that is likely to be a disturbance response.
[Plots NHMTECRN98SC0021, NHMTECRN98SC0028, NHMTECRN98SC0032]

Pinus ponderosa / *Carex inops* var. *heliophila* Woodland
[PINPON / CARINO]
Ponderosa pine / sun sedge woodland

This woodland type of limited extent is found as small patches within breakland or highly dissected and slumpy topography on moderate to steep slopes having cooler exposures. The highly erodible and immature soils are derived from shales. Sheet, rills and gully erosion, as well as plant pedicelling, are evident. This type exists in a mosaic with two other woodland communities; Ponderosa pine (*Pinus ponderosa*)-dominated patches having such erosive substrates that the undergrowth is virtually absent (< 5% canopy cover) and on cooler aspects small patches of the Douglas-fir / small-seeded indian ricegrass (*Pseudotsuga menziesii* / *Oryzopsis micrantha*) association are found.

Prior to this report, the type has only been identified and described by Hansen and Hoffman (1988) for southeastern Montana and adjacent portions of the Dakotas and by Hoffman and Alexander (1987) for Wyoming. It is notable that this type, as described by the above-cited authors, is outside the distribution limits of Douglas fir (*Pseudotsuga menziesii*). Though the stands on the RNA are dominated by an open canopy of *Pinus ponderosa* in the uppermost layer, as well as the reproductive layers, these sites are not so severe as to be beyond the limits of *Pseudotsuga menziesii* establishment and growth. Coring of the largest pine trees (*Pinus ponderosa*, 14-16 inches dbh, 38 ft. tall) reveals ages of at least 130 years; none of these trees have fire scars. The canopy cover of Rocky Mountain juniper (*Juniperus scopulorum*) ranges widely but, usually is in the 10-20% range.

The undergrowth of this association is dominated by graminoids. Shrubs and forbs are poorly represented. Fragrant sumac (*Rhus aromatica*) and Wood's rose (*Rosa woodsii*) are consistently present, occurring in trace amounts. Sun sedge (*Carex inops*) dominates the undergrowth with coverages generally not exceeding 30%. This contrasts with its representation in southeastern Montana stands where it is nearly sward-like, coverages mostly exceeding 80%. Bluebunch wheatgrass (*Pseudoroegneria spicata*) and western wheatgrass (*Pascopyrum smithii*) are consistently present in low coverages. Yarrow (*Achillea millifolium*) and American vetch (*Vicia americana*) appear to be the forbs most consistently present.
[Plot MHMTECRN98SC0031]

Populus deltoides / *Cornus sericeus* Temporarily Flooded Forest
[POPDEL / CORSER]
plains cottonwood / red-osier dogwood temporarily flooded forest

Note: This stand was sampled directly outside of the Refuge within James Kipp Campground area. It had previously been sampled by the Montana Riparian Association (Hansen et al. 1995); this data has been weighted heavily in characterizing dogwood as the undergrowth dominant in "natural", undisturbed cottonwood stands. This stand was sampled to satisfy our curiosity as to the composition and landscape position of a *Populus deltoides*-dominated stand that differed from all other such stands noted in the RNA. In terms of landscape position, relationship to the watertable and flooding regimes this stand appeared no different than those of the *P. deltoides* / *Symphoicarpos occidentalis* association seen upriver from this point. In extensive reconnaissance of the upriver bottomland stands only once did we find a shoot of red-osier dogwood (*Cornus sericeus*). Hansen et al. (1995) interpret POPDEL / SYMOCC as a browsing-induced seral expression of the POPDEL / CORSER community. This may be a plausible explanation for what was observed for *Populus deltoides* stands on the Missouri River Bottomlands. But it begs the question as to why the James Kipp Campground stand could escape browsing altogether for a period sufficient for *Cornus sericeus* to attain a height putting its foliage beyond the reach of browsers. This stand is also somewhat anomalous in either lacking other shrub species like western serviceberry (*Amelanchier alnifolia*, common chokecherry (*Prunus virginiana*), gooseberry species (*Ribes* spp.) or having their coverages much below ranges cited as typical for this community type as in the case of Wood's rose (*Rosa woodsii*) and western snowberry (*Symphoricarpos occidentalis*). For both the plot and the small examined portion of the total stand, the herbaceous cover was extremely depauperate. Clasping-leaved dogbane (*Apocynum sibiricum*) was the only forb noted.

Other Vegetation Types: The shoreline vegetation zones were not briefly described. They often included off-shore emergent bands of Three-square (*Scirpus pungens*), water sedge (*Carex aquatilis*) along the

shorelines, thickets or interrupted strips of coyote willow (*Salix exigua*) on the banks and flats, and open flats colonized by wild licorice (*Glycyrrhiza lepidota*) and *Pascopyrum smithii*. There were occasional grassy banks with scattered patches of prairie cordgrass (*Spartina pectinata*) and Canada wild-rye (*Elymus canadensis*), but they were heavily invaded by quackgrass (*Agropyron repens*) and smooth brome (*Bromus inermis*), so it was not clear whether this is a discrete local vegetation feature.

OVERALL BIODIVERSITY SIGNIFICANCE:
The Missouri River Bottomlands RNA has significance as representing a major Great Plains river valley and its accompanying natural succession and geological processes. It is a fitting example with three major islands, an array of cottonwood stands at different successional stages, bottomlands with the full suite of shrubland communities, and boundaries along app. nine miles that take in many of the valley slope communities.

It is contiguous with and is accessible overland via the Two Calf-Douglas-fir RNA, discussed below. The Douglas fir forest is not otherwise represented in Missouri River Bottomlands RNA, and the two together represent an outstanding example of the Missouri Breaks gradient and complement one another. Together they contrast with and complement the drastically different vegetation of the Limber Pine RNA, also in a Missouri Breaks setting over 60 miles east, but with a predominantly sandstone, rather than shale bedrock.

This RNA is known to harbor the following animals species of special concern: bald eagle (*Haliaeetus leucocephalus*), Ferrugineous hawk (*Buteo regalis*), Sturgeon chub (*Hybopsis gelida*), Sicklefin chub (*Hybopsis meeki*), and a major Missouri River population of pallid sturgeon (*Scaphirhynchus albus*) above Fort Peck. Most of these have territories that extend beyond the limits of RNA boundaries. Wildlife values were not evaluated.

LAND USE:
Extensive segments of the Missouri River bottomlands were plowed, representing over half of the bottomlands running through the center of the study area, and including all accessible, large flats. These were subsequently seeded to non-native species. Homesteaders also based their ranching operations in the valley, and prior to settlement, woodhawkers cut timber to supply passing ferries.

Most of the area has not been grazed since the late 1960s or the early 1970s (Haglan pers. commun.)

Boating, motorized travel on existing roads, and hunting are regular recreational activities. The site adjoins James Kipp Campground and Boat Ramp, and is the lower 9 mile end of the 149 mile-long Wild and Scenic segment of the Missouri River.

MANAGEMENT COMMENTS:
The flooding regime is modified by upstream impoundments, diminishing the magnitude of floods, increasing the rates of water erosion, and perhaps altering the character of ice jams. The highwater conditions of 1997 were reflected in overtopping cutbanks and new- or newly-expanded silt and gravel deposits.

Habitats that are flooded have the continuous threat of invasion by water-borne exotics like Russian knapweed (*Centaurea repens*), one of the most invasive exotic species at present in the bottomlands of the RNA. Water is not its only dissemination vector, and the bottomland plantings of non-native species are vulnerable to its expanded invasion in general. One of the most serious knapweed invasions is on Hess Bottoms, located above the best-condition cottonwood stands. Invasion by *Tamarisk chinensis* (tamarisk) is another serious potential threat to riverside habitat though it was not observed in the limited study area visit.

In the uplands, yellow sweetclover (*Melilotus officinalis*) is widespread and appears to be particularly abundant on shale uplands and some breakland areas that have burned.

Prairie Dog Island Research Natural Area

ENVIRONMENT:
Prairie Dog Island is a 15 acre island in the upper end of the Dry Arm, a major south-trending arm at the eastern end of Fort Peck Reservoir. Its highest point rises less than 60 feet above water level. This site is somewhat atypical of Missouri River Breaks Subsection (f) of the Northwestern Glaciated Plains Section (331D, Nesser et al. 1997) in that it is not dissected but gently rolling terrain and the predominant soil texture is a fine sandy loam, indicating a weathering from mainly sandstone. The climatic regime is essentially Continental with hot summers and frigid winters; 35%

of average annual precipitation (11.5 in.) occurs in May and June (data averaged over years 1956 to 1998, from Fort Peck Power Plant, Western Region Climate Center).

VEGETATION:
The great majority of the island was at one time a black-tailed prairie dog (*Cynomys ludovicianus*) colony, that has been extirpated as the result of sylvatic plague. During the colony's existence or following its demise, *Bromus tectorum* established in dense swards over the area occupied, or once occupied, by the colony. Only two plots were established to document the island's vegetation composition, one representing this community within historic prairie dog colony, and the other representing the probable undisturbed native vegetation.

Bromus tectorum Disturbance Vegetation
[BROTEC]
cheatgrass disturbance vegetation

Cheatgrass (*Bromus tectorum*) is the dominant species in the area formerly occupied by prairie dog colony. Cheatgrass cover is variable, but generally is in excess of 60% and ranges as high as 90%. A number of species that were once prominent on the site, inferred from composition of adjacent landscape, are still present, including silver sagebrush (*Artemisia cana*), fringed sage (*Artemisia frigida*), blue grama (*Bouteloua gracilis*), needle-and-thread (*Stipa comata*), indian ricegrass (*Oryzopsis hymenoides*) and scarlet globemallow (*Sphaeralcea coccinea*). However, the site is dominated by weedy, increaser species that also include common dandelion (*Taraxacum officinale*), tumblemustard (*Sisymbrium altissimum*), goat's beard (*Tragopogon dubius*), Russian thistle (*Salsola kali*), and rough pennyroyal (*Hedeoma hispidum*). [Plot NHMTECRN98SC0004]

Stipa comata – Bouteloua gracilis – Carex filifolia
Herbaceous Vegetation
[STICOM – BOUGRA - CARFIL]
needle-and-thread – blue grama – threadleaf sedge grassland

This is the prevailing grassland where sandy deposits are extensive, as at Prairie Dog Island. The composition of the sampled site, representing the fraction of vegetation not impacted by the "dog town", matches the modal conditions described for this plant association with *Stipa comata* dominant and *Bouteloua gracilis* and *Carex filifolia* being subsidiary graminoids (Hansen and Hoffman 1988, Jensen et al. 1992). Of only four forbs present, scarlet globemallow (*Sphaeralcea coccinea*) is the dominant. The presence of silver sagebrush (*Artemisia cana*) probably reflects the high water table. This site has also received some past disturbance, as evidenced by several alien species being present. [Plot NHMTECRN98SC0005].

The unvegetated sandy shore ends abruptly in cutbank with no intervening vegetation gradient between it and the grassland.

OVERALL BIODIVERSITY SIGNIFICANCE:
This site has limited merit as an RNA due to the explosion of weed populations, particularly *Bromus tectorum* (cheatgrass). This condition may reflect the combined history of prairie dog use and surrounding land use. Even if this site were in pristine condition, it would have limited vegetation significance because it represents a single major community type; one that is best represented as part of a large, contiguous landscape.

The presence of colonial nesting birds was evident and warrants enumeration. Cutbanks on the leeward (southeastern) shore were favored as perches and shoreline nest sites. The original establishment record said that this site also provides habitat for burrowing owl; it is unclear whether this meant that breeding of this species had been documented or suspected. Existing and potential wildlife significance may warrant further consideration.

OTHER VALUES:
Like the Manning Corral RNA, this site could be used to track plant succession in the wake of prairie dog use, or be considered for prairie dog reintroduction.

LAND USE:
Grazing by large ungulates, if it occurs at all, would be confined to winter when the frozen-over reservoir provides the only access, but it was once part of primary range for livestock grazing. Until recently, it was also subject to foraging from prairie dogs in the main colony.

MANAGEMENT COMMENTS:
Weeds and increaser species are prevalent on this site. Native graminoids and forbs are present, but there is no indication that they can outcompete the weed population to reestablish their dominance. Though there are various theories on cheatgrass invasion (Young and Allen), the projections are similar. On comparable sites of the Columbia Basin and Great Basin, despite a 40 year hiatus in disturbance, cheatgrass (*Bromus tectorum*) has continued - and even

increased - its site dominance (Mack 1981). There is low potential for the return of natural vegetation on Prairie Dog Island. A large sward of Canada thistle (*Cirsium arvense*) adjoins the southeast end where bird use seemed heaviest. The plains cottonwood (*Populus deltoides*) and tamarisk (*Tamarisk chinensis*) that had established along the shoreline were innundated and killed in the high water conditions of 1997-98.

Spring Creek Research Natural Area

ENVIRONMENT:
Spring Creek RNA is a 160 acre tract that encompasses an incised ravine system, adjoining tableland, and valley slopes along the Dry Arm of Fort Peck Reservoir. It is part of the Missouri River Breaks (Subsection f) of 331D (Nesser et al. 1997). The 190 ft. of vertical relief dissects both sandstone and underlying siltstone bedrock. It is situated north of Spring Creek and Spring Creek Bay, with an ephemeral streamcourse that empties westward into the Reservoir. Upland soils, upper ravine slopes, and ravine bottom soils are fine sandy loams developed from the underlying bedrock. Lower ravine slopes, benches and valley slopes are silt loams (shale derived). The climate is essentially Continental (refer to the characterization of Fort Peck monitoring data, presented for Prairie Dog Island RNA.)

VEGETATION:
Well-developed expressions of tableland and ravine slope plant communities are found, as well as a stringer of woody draw vegetation that has a prevalent green ash (*Fraxinus pensylvanica*) component in the canopy mixture. The original designation of this RNA to preserve an unusual stand of aspen (*Populus tremuloides*) may have been based on the interpretation that this species, being the tallest in the ravine, is the stand dominant. The complement of plant associations does not have one that is clearly more extensive than any other. Perhaps the most extensive, though variable, cover type is comprised of the Wyoming big sagebrush shrubland (*Artemisia tridentata* ssp. *wyomingensis* Shrubland) on benches at the mouth of the ravine and valley slopes above the reservoir.

Artemisia tridentata ssp. *wyomingensis* / *Pascopyrum smithii* Shrubland
[ARTTSW / PASSMI]
Wyoming big sagebrush / western wheatgrass shrubland

This association is a major vegetation type both in the study area and across the Northern Great Plains from Colorado north to Saskatchewan, on both glaciated and non-glaciated surfaces. The majority of the type occurs in Wyoming and Montana. It generally occurs, as on this RNA, over large areas, except at the periphery of its range, where it may occur in small patch fragments. There are several recognized names and variations for the Wyoming big sagebrush/ western wheatgrass shrubland (including *Artemisia tridentata* / *Pascopyrum smithii*, *Artemisia tridentata* ssp. *tridentata* / *Pascopyrum smithii*, *Artemisia tridentata* / *Elymus lanceolatus*, *A. tridentata* / *Pascopyrum smithii* – (*Elymus lanceolatus*) [Schneider et al. 1997, Vanderhorst et al. 1998].) Some of these differ only in that the subspecies of big sagebrush was not stipulated or known at the time the investigations were conducted. Only the *Artemisia tridentata* ssp. *tridentata* association (ARTTST) represents a distinct habitat, one more associated with swales and drainages and found to the west of the ARTTSW / PASSMI type. The ARTTSW / PASSI type is generally associated with low relief uplands, benches, plateaus, or rolling terrain but within most of the RNA these flatter surfaces are sandstone capped and favor needle-and-thread (*Stipa comata*)-dominated grasslands, whereas the *Artemisia tridentata* communities are found downslope on gentle inclines with heavier-textured soils (silty clay loams). This association, including the RNA representation, has considerable exposed surfaces (soils mainly), generally in excess of 50%.

The shrub canopy of *Artemisia tridentata* ssp. *wyomingensis* is variable in cover, but generally in the vicinity of 20-30%, straddling the shrubland to herb-dominated structural break according to NVCS. Winter fat (*Krascheninnikovia lanata*) and Fringed sage (*Artemisia frigida*) are present in trace amounts, though areas of disturbance support more *Artemisia frigida*. Western wheatgrass (*Pacopyrum smithii*) and threadleaved sedge (*Carex filifolia*) are the dominant graminoids, their combined cover usually not exceeding 50%. Green needlegrass (*Nasella viridula*) is present, mostly under the protective canopy of *A. tridentata*, raising some speculation, at least for the footslope positions, that ARTTSW / PASSMI – *Nasella viridula* may be the potential community type. Certainly in the past, livestock grazing pressure might have been extreme and led to significantly reduced coverage for the highly palatable *Nasella viridula*. The forb component is both sparse and species poor. In the plot, two of the four species, including plains prickly-pear (*Opuntia polyacantha*) and brittle prickly-pear (*Opuntia fragilis*) are associated with overgrazing, though their

low cover here would not necessarily indicate overgrazing at present or in the recent past. Scarlet globemallow (*Sphaeralcea coccinea*) is a forb found here and across all manner of range sites. [Plot NHMTECRN98SC0008]

Stipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation
[STICOM – BOUGRA – CARFIL]
needle-and-thread - blue grama – threadleaved sedge grassland

This is one of the most extensive of Great Plains grassland community types, occurring from the Midwest to the Rocky Mountain Front of Montana and north well into Saskatchewan and Alberta. In eastern Montana and North Dakota it occurs, as at this site, on soils with a higher percentage of sand than is represented in soils of adjacent communities; it occurs on both glaciated and unglaciated landscapes. In eastern Montana landscapes these sites are frequently on ridge systems where sandstone strata are exposed. In the shale- and siltstone-dominated plains of eastern Montana it is often manifested as a small patch type on projecting ridge crowns and hillocks.

It has also been the subject of some vegetation classification uncertainty because there have also been two other plant associations named with needle-and-thread in separate combination with the two other species. There is no existing unequivocal key to vegetation types that can distinguish among these types, so the most inclusive name was chosen, one that appears to fit published descriptions of the type (Allen et al. 1999). This type is potentially extensive on the sandstone-underlain benchlands that cap the local landscape. It is in particularly good condition as it occurss within the RNA whereas this type has undergone a grazing-induced conversion to a fringed sage (*Artemisia frigida*) and blue grama (*Bouteloua gracilis*)-dominated disclimax on directly adjoining tracts separated by fence. Litter and lichens dominate the ground cover within the RNA type and are a decidedly reduced outside the fenceline, where exposed soil is the dominant surface category.

Within the RNA's expression of this type, *Artemisia frigida* is the only shrub-like plant, present in trace amounts. Needle-and-thread (*Stipa comata*) strongly dominates the herbaceous component. Throughout this grassland, threadleaved sedge (*Carex filifolia*) has cover values ranging from 50 to 70 %, though blue grama (*Bouteloua gracilis*), is still an important component. Western wheatgrass (*Pascopyrum smithii*) is consistently present in trace amounts in contrast to its greater cover on adjacent heavier-textured soils. There are no forbs with greater than trace amounts of cover; those noted to have with high constancy in this type and present throughout the stand are rush skeletonweed (*Lygodesmia juncea*) and scarlet globemallow (*Sphaeralcea coccinea*). [Plot NHMTECRN98SC0006]

Fraxinus pennsylvanica / Prunus virginiana Temporarily Flooded Forest
[FRAPEN / PRUVIR]
green ash / chokecherry temporarily flooded forest

Typically this type occurs along riparian corridors, springs and ponds and other floodplain positions, but in this landscape it is associated with v-shaped ravines known colloquially as "woody draws". It is very similar to the green ash-American elm/ western snowberry forest (*Fraxinus pennsylvanica – Ulmus americana / Symphoricarpos occidentalis* Forest) identified for North and South Dakota, though in Montana only slightly more than 10% of the stands of this type have *Ulmus americana* present. Most of this stand is confined to the ravine bottom and toeslope positions. The forest floor is nearly completely covered with litter, the limited ungulate trails being the only areas where soil that is sandstone-derived, fine sandy loam is exposed. This example of the type is of good to moderate quality due to the dominance of the alien *Poa pratensis* (Kentucky bluegrass) and the somewhat low diversity of the forb component, though noxious weeds are not present

The upper canopy is rather open, appropriately classified as woodland cover (40-60%) and height (25 ft.), with *Fraxinus pennsylvanica* generally the dominant tree species, as well as being represented in all layers of the multi-storied canopy. Conks (bracket fungi) were present on almost all larger *Fraxinus* stems, though elevated mortality rates were not evident. In some portions of the stand quaking aspen (*Populus tremuloides*) is codominant with the *Fraxinus*. Both *Populus tremuloides* and Rocky Mountain juniper (*Juniperus scopulorum*) also occur in multiple size classes throughout the stand. The shrub component is relatively diverse with at least seven species consistently represented. Common juniper (*Juniperus communis*) and western snowberry (*Symphoricarpos occidentalis*) are the dominants, but if the browsing pressure on chokecherry (*Prunus virginiana*) and western serviceberry (*Amelanchier alnifolia*) were relaxed, it is possible that these species might increase in cover. Past disturbance is probably the reason that Kentucky bluegrass (*Poa pratensis*) is the dominant grass. Other important grasses are Canada wildrye

(*Elymus canadensis*) and bearded wheatgrass (*Elymus trachycaulis*). Starry Solomon-plume (*Smilacina stellata*) and horsemint (*Monarda fistulosa*) are uniformly well-distributed, the only forbs among the eight total occurring in greater than trace amounts. Absent are forbs such as purple meadowrue (*Thalictrum dasycarpum*), northern bedstraw (*Galium aparine*) and Sprengel's sedge (*Carex sprengelii*) that quite often inhabit these sites; their absence could be attributed to poorly-developed soils or to habitat conditions. [Plot NHMTECRN98SC0007]

Juniperus horizontalis / Schizachyrium scoparium Dwarf Shrubland
[JUNHOR / SCHSCO]
creeping juniper / little bluestem dwarf shrubland

This association, both at large and within the RNA, is characterized as a topoedaphic climax, found on moderate to steep, potentially highly erosive slopes of fine sands to sandy loams, with north- to east-facing exposure. In some instances it does occur on flatter slopes, but still the substrate is prone to erosion. For the most part, patch size is dependent upon local vertical relief of appropriate substrate, which is limited in the RNA and thus the type is exemplified by small patches occurring on cooler exposures of steeply incised ravines. There are several other associations having creeping juniper (*Juniperus horizontalis*) dominant but they differ somewhat with regard to the graminoid component. All occur on coarse-textured, erosive soils, but some, such as *Juniperus horizontalis / Carex inops*, are confined to steep cool exposures (Hansen and Hoffman 1988).

Juniperus horizontalis generally has greater than 60 % cover at these sites and is the primary substrate binding agent; other shrubs occur in trace amounts. Within the plot, the dominant graminoid is threadleaf sedge (*Carex filifolia*) but the indicator graminoid is actually bluebunch wheatgrass (*Pseudoroegneria spicata*). Across the local landscape there was a fluctuation as to which of these two species is dominant. The grass for which the type is named, little bluestem (*Schizachyrium scoparium*), is at best, sporadically distributed in this RNA, though overall its distribution is largely coextensive with that of *Pseudoroegneria spicata* in considering sites of this nature and in this region (thus its attribution as an indicator species as well). Other grasses present and typical of sandy sites include plains reedgrass (*Calamagrostis montanensis*) and prairie sandreed (*Calamovilfa longifolia*). The forb component is diverse, ranging up to 20 species on a plot, but only one or two species, usually standing milkvetch (*Astragalus adsurgens*) or purple prairie clover (*Petalostemon purpureum*), are present in greater than trace amounts.
[Plot NHMTECRN98SC0009]

Rhus aromatica / Pseudoroegneria spicata Shrubland
[RHUARO / PSESPI]
fragrant sumac / bluebunch wheatgrass shrubland

The sample plot is representative of steep, erosive and high solar intensity slopes, mostly of upper slope and slope shoulder positions. This association occurs predominantly as small patches. This severe and heterogeneous environment has a concomitantly sparse and variable vegetation composition with dominance in the shrub component alternating, in no readily explained manner, between soapweed yucca (*Yucca glauca*) and fragrant sumac (*Rhus aromatica*). The soils are fine sands to sandy loams in texture and rills, gulleys and faceted slopes are testimony to their erosive nature. There are at least six closely related plant associations that occur as small patch types on sites with abiotic parameters comparable to those of RHUARO / threadleaf sedge (*Carex filifolia*), RHUARO / little bluestem (*Schizachryium scoparium*), RHUARO / plains muhly (*Muhlenbergia cuspidata*), *Yucca glauca / Calamovilfa longifolia*, and *Yucca glauca / Pseudoroegneria spicata* (Hansen and Hoffman 1988, Jensen et al. 1992, Schneider et al. 1997, DeVelice et al. 1995). There are no vegetation keys that permit one to unequivocally identify/differentiate these communities, but the site descriptions and vegetation parameters most closely match the RHUARO / PSESPI association described by DeVelice et al. (1995) for northcentral Montana and RHOARO/ PSESPI (Shallow Depth Ecological Type) by Jensen et al. (1992) for western North Dakota.

Rhus aromatica, *Yucca glauca*, *Juniperus horizontalis* and *Artemisia frigida* are ubiquitous shrubs in this type, but only the first three listed exhibit even 5% canopy cover within this landscape; all other shrubs are present in trace amounts. These low shrub coverage values are not in accord with the modal description of the type on a regional basis. For the sample plot, and most of association as developed on the RNA, there is not a dominant graminoid; rather there exists an assemblage of graminoids typical of coarse-textured, well-drained sites. In approximate order of importance, in decreasing cover, these include: plains muhly (*Muhlenbergia cuspidata*), little bluestem (*Schizachryium scoparium*), bluebunch wheatgrass (*Pseudoroegneria spicata*), prairie sandreed (*Calamovilfa longifolia*), indian ricegrass (*Oryzopsis hymenoides*),

needle-and-thread (*Stipa comata*), sand dropseed (*Sporobolus cryptandrus*) and red threeawn (*Aristida longiseta*). Other short graminoids, not necessarily associated with coarse-textured soils, can also dominate these sites.The forb component is low in cover and extremely heterogeneous, with high diversity (30 plus species / plot-sized area) in some areas and scarcely one third that in others. Almost ubiquitous within the type are hairy golden-aster (*Heterotheca villosa*), American vetch (*Vicia americana*), scarlet globemallow (*Sphaeralcea cocinea*), scarlet gaura (*Gaura coccinea*), silver-leaf scurf-pea (*Psoralea argophylla*) and woolly groundsel (*Senecio canus*).

Other Vegetation Types: Where the woody draw opens up and widens some distance above the reservoir, the *Artemisia cana / Pascopyrum smithii* (silversage / western wheatgrass) association is found contained within what becomes a broad, shallow drainage. This community is in relatively good range condition as indicated by the high cover of *Pascopyrum smithii* and low cover of Kentucky bluegrass (*Poa pratensis*). Comparatively large specimens of *Artemisia tridentata* ssp. *wyomingensis* contribute to the high shrub cover.

OVERALL BIODIVERSITY SIGNIFICANCE:
The boundaries were set to encompass the ravine, a particularly well-developed landform with its full complement of associated vegetation. The ravine itself is an unusually mesic woodland in its composition for the Northern Great Plains biome, though limited in development and extent as is the case for most Missouri Breaks ravines due to their narrowly-incised settings of limited length. This gives it all the more contrast and development in north-south ravine slope vegetation as a consequence. A segment of the surrounding upland grassland features are serendipitously included that are representative of a prevailing Northwestern Unglaciated Plains landscapes in excellent condition. Such grassland habitat extends onto adjoining lands to provide landscape continuity, though adjoining lands are not in as good a condition. As such, Spring Creek RNA potentially affords a rangeland reference area for land managers and ecology researchers, and a striking fenceline contrast in range condition between adjoining pastures. Wildlife values were not evaluated.

LAND USE:
The site has been protected from livestock grazing to keep the area in a natural state, presumably since establishment in 1991. The current excellent condition and paucity of exotic species suggests that it had been managed in good-excellent range condition prior to establishment.

MANAGEMENT COMMENTS:
No immediate management issues or concerns were identified; there is a nearly complete absence of noxious weeds and exotic species invasions with only limited yellow sweetclover (*Melilotus officinalis*) along the western bottoms. Vehicle access is limited, and weeds were found along the corridor.

Historically, fire and bison grazing were two major driving forces in this landscape, responsible for renewing the vigor of the grasses, stimulating forb numbers, and keeping shrub density low. Reintroduction of appropriately timed fire is a management option to consider in stimulating grass upland grass vigor and forb flowering, within the wildlife management framework.

The grassland had relatively low forb numbers and litter accumulation. A policy excluding wildfire suppression under discrete terms, if not a rotating prescribed burn treatment, may warrant further consideration. The consideration of any treatment must factor in yellow sweetclover life history and responses.

Two Calf-Douglas-fir Research Natural Area

ENVIRONMENT:
Two Calf-Douglas-fir Research Natural Area is a 160 acre block of Missouri Breaks that encompasses an almost 500 feet vertical gradient of moderately to highly dissected terrain developed in highly erodible shales. It encompasses the upper slopes of Knox Ridge and extends northward down to the Missouri River; thus the mostly steep slopes have contrasting north- and south-facing exposures. Barely reaching the southern boundary, in the vicinity of an ephemeral stream feeding Two Calf Creek, a wildfire has burned the predominantly pine forest, leaving scattered blackened snags. At the northern base of the ridge, the ridge slope tapers into highly convoluted slump block terrain with small-scale relief that is not revealed by 40 feet contour intervals. The climate is essentially Continental (refer to the characterization of Mobridge monitoring data, presented for Missouri River Bottomlands RNA.)

VEGETATION:
Bisected as it is by a east-west oriented ridge, the RNA's predominant vegetation cover includes moderately to densely forested north-facing slopes and open woodlands and sparsely vegetated south-facing slopes.

Pseudotsuga menziesii / Oryzopsis micrantha Forest
[PSEMEN / ORYMIC]
Douglas fir / little-seed ricegrass forest

This forest type is of very limited rangewide distribution, found only in the Missouri River Breaks of Montana. It was originally characterized by Roberts and Sibbernsen (1979) as Douglas fir / plains muhly forest (*Pseudotsuga menziesii / Muhlenbergia cuspidata* Forest) as a result of misidentifying the dominant grass in vegetative condition. It occupies moderate to steep slopes with northwest to northeast aspects. This is a major type within the RNA, where it is best-developed on steep north-facing slopes that are very undulating in both the horizontal and vertical. It appears to be developed on the same erodible shale substrate that supports other forested types as well as long-leaved sagewort/indian ricegrass barrens on south exposures. The ground surface has a patchy cover of mosses and lichens, the combined cover of which generally exceed 50%; about 40% is contributed by litter and the remaining 10% is bare soil which shows sheet and rill erosion in places. There were no fire scarred trees or buried charcoal which tends to support the contention of Roberts et al. (1979) that these sites experience low fire frequencies. This type usually grades to ponderosa pine woodland on drier/warmer slopes or on flats and toeslopes below.

The overstory approaches canopy closure with *Pseudotsuga menziesii* (Douglas fir) strongly dominant and *Pinus ponderosa* (Ponderosa pine) scattered. The understory has numerous stems of *Pseudotsuga menziesii*, and Rocky Mountain juniper (*Juniperus scopulorum*) in a distinctly shrubby form. The canopy is too dense for *Pinus ponderosa* reproduction, clearly making *Pseudotsuga menziesii* the climax dominant and apparently seral dominant as well.

Further evaluation of old-growth characters may be warranted. Tree ring studies were conducted among Douglas fir at a study site referred to by the nearby "James Kipp Recreation Area" out of the National Laboratory of Tree Ring Research; they documented the oldest age among sampled Douglas fir trees to be 491 years (L. Smith pers. commun. to J. McCollum, 1982).

The rhizomatous western snowberry (*Symphoricarpos occidentalis*) is present in patches as the dominant shrub; squaw currant (*Ribes cereum*) is consistently present, as is the intensively browsed common chokecherry (*Prunus virginiana*). The dominant herb, little-seed ricegrass (*Oryzopsis micrantha*) is highly variable in cover; the sample plot represents the high end (40%) of this species' cover values. Sun sedge (*Carex inops*) and bluebunch wheatgrass (*Pseudoreogneria spicata*) are consistently present with coverages generally not exceeding 5%. Oregon woodsia (*Woodsia oregana*) is a fern occurring in more than trace amounts; forb cover is lower than this. Yellow sweetclover (*Melilotus officinalis*) is also present in trace amounts despite the shaded environment, confirming its aggressive nature and broad ecological amplitude. [Plot NHMTECRN98SC0013]

Pinus ponderosa / Carex inops Woodland
[PINPON/CARINO]
Ponderosa pine / sun sedge woodland

On the steep, south slopes a complex of open pine woodland vegetation encircled the sparse vegetation associations of the long-leaved sagewort / indian ricegrass barrens. The open pine stands represent a wooded shale barrens complex in which there were frequent clumps of sun sedge (*Carex inops*), but undergrowth vegetation was sporadic, sparse over most of the area, and variable in composition. Plains reedgrass (*Calamagrostis montanensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) were also locally abundant. Multiple plots would be needed to make generalizations and characterize the highly variable structure. This plant association has been documented as a distinct woodland community on isolated shale outcrops such as the War Horse Area of Critical Environmental Concern (Lesica 1987), and on secondary tributaries of the Missouri River such as Woodhawk Creek (Heidel 1996) where it is generally better-developed under less harsh conditions. [No Plot]

The virtually ubiquitous ponderosa pine of the plains has been employed for reconstructing climate history as indicated by tree ring patterns. Ponderosa pine elsewhere on the Refuge have been cored to document Great Plains drought history (Meko 1982, 1992).

Artemisia longifolia / Oryzopsis hymenoides Sparse Vegetation
[ARTLON / ORYHYM]
long-leaved sagewort / indian ricegrass barrens

This community was found on steep, south-facing slopes eroded from acid shales that heat up under direct exposure to the sun. Both of the community co-dominants, long-leaved sagewort (*Artemisia longifolia*) and few-flowered wild buckwheat (*Eriogonum pauciflorum*) are highly associated with soils derived from acid shales (in Montana the Bearpaw, Colorado and Clagget Shales) and bentonite. These shales are intrinsically highly erosive, with sheet, rill and gully erosion evident on site. Plant establishment is further hindered by low pH values (< 5) and low values for moisture available to vegetation. Thus, these sites are very stressful for vegetation and support a suite of uniquely adapted species, which individually, or in the aggregate, seldom exceed 10% canopy cover (the value defining the break between sparse/not sparse in the NVCS). We have placed the inventoried stand into this association using the key of DeVelice et al. (1995); the congruence between our plot and their description of this type, regarding both environment and vegetation, is close. Several species present are generally associated with sandy soils such as soapweed yucca (*Yucca glauca*), indian ricegrass (*Oryzopsis hymenoides*), and prairie sandreed (*Calamovilfa longifolia*). They are found on these clay shales because the weathering process produces a substrate of predominantly sand-sized platy shards rather than the clay-sized particles that are the ultimate product of shale decomposition. Forbs typical of disturbed sites occur in trace amounts.

Other vegetation: In the northern portion of the RNA, where the ridge slope tapers into highly convoluted slump block terrain, there is a fragmented and repeating pattern in plant communities within a short distance, with most of the communities occupying only a few square meters. Some of the communities noted but not formally sampled were *Pinus ponderosa / Carex inops* and a *Pinus ponderosa*-dominated type that had virtually no undergrowth due to the highly erosive nature of the substrate. These types were not sampled because the surface was so rolling and convoluted that there was no portion extensive enough to accommodate a plot sample.

Other Vegetation Types: Small patches of the following types were noted; *Chrysothamnus nauseosus – Eriogonum pauciflorum* (a variation of ARTLON - ERIPAU), PASSMI; SARVER – ATRGAR and ARTTSW / PASSMI.

OVERALL BIODIVERSITY SIGNIFICANCE:
This is significant as the only RNA that contains the uncommon to rare PSEMEN / ORYMIC Forest. It encompasses an interesting contrast of vegetation for a small area; juxtaposed with the north slope PSEMEN / ORYMIC c.t. is ARTLON / ORYHYM occurring on the steep south slopes. As such, this RNA captures an unusual slice of the Great Plains biome.

Two Calf-Douglas-fir RNA is contiguous with and provides access to the Missouri River Bottoms RNA below. While the latter does not provide additional PSEMEN/ORYMIC habitat, the two together represent an outstanding example of the Missouri Breaks gradient and complement one another.

The relatively dense canopy of the PSEMEN / ORYMIC and other forested types of northerly slopes constitute important thermal and hiding cover for large native ungulates. The palatable shrubs of these slopes, including serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*) have been reduced to stubs only inches high presumably due to intensive wildlife browsing.

The skewed orientations of otherwise straight tree trunks ("drunk forest") raised questions about the history of slumping. The massive slope wasting phenomena currently under intact vegetation signifies an interesting subject for research into "natural" stability/instability of this landscape.

LAND USE:
The general area has been grazed in the past but local conditions are unfavorable for such use. It may have been subject to selective removal of suitable trunks of *Juniperus scopulorum* cut for fencing, and trunks of *Pseudotsuga menziesii* cut for fuel and building material from the perimeter of the stand where access and removal were practical.

MANAGEMENT COMMENTS:
This 160 acre patch is too small to encompass the disturbance regimes (wildfire, wildlife browsing and grazing) affecting the Missouri Breaks landscape. If a wildfire were to burn the northern slope, it would probably crown-out and be stand replacing for most of the forested landscape, setting back the forested landscape to an early seral stage. Tree seedling establishment in such an environment is very sporadic, and it takes many years for an established forest to produce a mature stand in this dry enviroment. Given the rarity of the type and relative lack of its protection in Montana, it would be prudent to either add more area of this association to the current RNA or find additional examples of high quality PSEMEN / ORYMIC that could be placed in RNA status. Note:

Fire suppression was identified in the original establishment record as needed to maintain the vegetation.

There is currently not a weed threat to the area, but the introduced yellow sweetclover (*Melilotus officinalis*) is aggressive and can be seen invading environments as disparate as PSEMEN / ORYMIC and ARTLON / ORYHYM. While it has the greatest potential for expansion on the shrub and grassland sites within the area, it could also proliferate with fire or other major changes to forested community structure.

The Knox Ridge road is a maintained BLM road running through the area that is a potential corridor for new invasions of exotic species. Any road-grading work on such a steep-sided, narrow ridge also presents the possibility of destabilizing the slopes that drop off on either side.

York Island Research Natural Area

ENVIRONMENT:
York Island is a 120 acre island in the eastern end of Fort Peck Reservoir in a highly exposed setting at the juncture of the main reservoir and the Dry Arm. Its highest point rises less than 80 feet above water level. The undulating to sharply incised surface is typical of Missouri River Breaks Subsection (f) of the Northwestern Glaciated Plains Section (331D, Nesser et al. 1997) where dissected river breaks have formed in shale, sandstone and siltstone. Most of the island's communities are developed on soils weathered from fine-textured sedimentary parent materials, including montmorillinitic clay, i.e. bentonite, a water deposited volcanic ash. The climatic regime is Continental with hot summers and frigid winters; 35% of average annual precipitation (total 11.5 in.) occurs in May and June (data averaged over years 1956 to 1998, from Fort Peck Power Plant, Western Region Climate Center).

VEGETATION:
This site has two major community types, both dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). While the cover of this species is quite variable, it averages in the mid-20% range, i.e., close to the 25% threshold for distinguishing between shrubland and herbaceous vegetation (Federal Geographic Data Committee—Vegetation Subcommittee 1997.) We have described only the *Artemisia tridentata* shrub associations (shrub canopy cover > 25%) because they appeared to be more prevalent and their intergradation with the herbaceous associations is structurally and compositionally overlapping without a discretely different herbaceous type at another extreme.

Artemisia tridentata ssp. *wyomingensis* / *Pascopyrum smithii* Shrubland
[ARTTSW / PASSMI]
Wyoming big sagebrush / western wheatgrass shrubland

This is the most extensive of the island's vegetation types, occurring on fine-textured silt and clay loams derived from shale and siltstone, and found on upland benches and gently to moderately inclined slopes of all aspects. Its varies between the more densely vegetated undulating uplands and more sparsely vegetated south-facing slopes, inversely related to the amounts of exposed soil and gravels (less than 20% - over 80%, respectively). Traces of scattered rounded rock are testimony to past glaciation but veneers of till were not found as part of the soil profile.

Upland sites have a notably well-developed microbiotic crust, including crustose lichens and algae, that constitute as much as 80% cover. This is circumstantial evidence that the site is a refuge from grazing ungulates, and previously had light use when it was contiguous with the mainland.

As noted above, Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) dominates the shrub component, coverages varying from approximately 15 to 30% but giving a distinct impression of a shrubland. Other shrubs/subshrubs present, generally in less than trace amounts, are fringed sage (*Artemisia frigida*), broom snakeweed (*Gutierrezia sarothrae*), and fragrant sumac (*Rhus trilobata*). The graminoid component is dominated by western wheatgrass (*Pascopyrum smithii*) with higher coverages (to 60-70%) occurring on rolling uplands. Other graminoids commonly present but in amounts not exceeding 5%, include: narrowleaved sedge (*Carex stenophylla*), sun sedge (*Carex inops*), needle-and-thread (*Stipa comata*), blue grama (*Bouteloua gracilis*), and prairie junegrass (*Koeleria macrantha*). Green needlegrass (*Nasella viridula*) is sporadically present; higher coverages of *Nasella viridula*, generally on lower north-facing slopes or toeslope postions, indicate a transition to more mesic and relatively scarce habitats (and the ARTTSW / PASSMI-NASVIR association). The forb component constitutes little cover, the most constant species being scarlet globemallow (*Sphaeralcea coccinea*), northern

fairy-candelabra (*Androsace septentrionalis*), and Nuttall's pussy-toes (*Antennaria parviflora*).

Yellow sweetclover (*Melilotus officinalis*) is uncommon in the sampled stand but widespread; other expressions of this association are densely carpeted with this introduced species and it has high potential for expansion. Other introduced species such as *goat's beard (Tragopogon dubius)* and Japanese brome *(Bromus japonicus)* generally have insignificant populations. [Plot NHMTECRN98SC0001]

Artemisia tridentata ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland
[ARTTSW / PSESPI]
Wyoming big sagebrush / bluebunch wheatgrass shrubland

This association is typical of the mid- to upper-slope positions of steeper slopes of all aspects, associated with glacial drift soils, both coarser-textured (mostly sandy loams) and having greater amounts of gravel than the ARTTSW / PASSMI p.a. It grades to ARTTSW / PASSMI both at downslope positions and at slope shoulders. Generally both the amount of bare soil and the exposed gravel/rock comprise upwards of 70% of the substrate; the erodible surface probably accounts for the lack of a microbiotic soil crust. Wyoming big sagebrush (*Artemisia tridentata* ssp. *Wyomingensis*) ranges in cover from 10% to upwards of 35 % but generally exceeds 20%. Fringed sage (*Artemisia frigida*), broom snakeweed (*Gutierrezia sarothrae*), soapweed yucca (*Yucca glauca)* and aromatic sumac (*Rhus trilobata)* are the shrubs consistently present in trace amounts. Bluebunch wheatgrass *(Pseudoroegneria spicata)* is the dominant graminoid, though its cover does not much exceed 30%. Graminoids consistently present with low covers and associated with coarser-textured substrates, or well-drained xeric sites include, plains muhly *(Muhlenbergia cuspidata)*, prairie sandreed (*Calamovilfa longifolia*), and sand dropseed (*Sporobolus cryptandrus*). Little bluestem (*Schizachyrium scoparium*) is often present. The forb component is very weakly represented; no one species can be said to be abundant but scarlet globemallow (*Sphaeralcea coccinea*), brittle prickly-pear (*Opuntia fragilis*), Hood's phlox *(Phlox hoodii*) and American vetch (*Vicia americana*) are consistently present. [Plot NHMTECRN98SC0002]

Chrysothamnus nauseosus / Eriogonum pauciflorum Sparse Vegetation
[CHRNAU / ERIPAU]
common rabbitbrush / few-flowered wild buckwheat barrens

This localized and small patch association is found on the island's uppermost outcrops and has been previously described in the Limber Pine RNA, in Valley County (Branson et al. 1970) and in Carter County (Vanderhorst et al. 1998). Soils of this site possess no horizons and are weathered from a very dark grey, possibly acidic, shale and bentonite. Though the ultimate result of weathering is clay-sized particles, much of the substrate has just been broken down to sand-size particles and thus has better drainage than would be expected of a soil high in clay; it is also highly erosive, rills and gullies abound. This association mostly occupies upper hill slopes or crests and has depauperate vegetation (<10% canopy cover). There is a suite of species adapted to these sites including long-leaved sagewort (*Artemisia longifolia*), common rabbitbrush (*Chrysothamnus nauseosus*), few-flowered wild buckwheat (*Eriogonum pauciflorum*; *E. brevicaule* var. *brevicaule* in southeast Montana), indian ricegrass (*Oryzopsis hymenoides*) and western wheatgrass (*Pascopyrum smithii*) that regularly appear in various mixes and quantities. On York Island, *Eriogonum pauciflorum* has greater cover than associated species, and *Chrysothamnus nauseosus* cover is less than 3%. The 19 species of the sample plot is an unusually high number; normally species richness does not exceed 5-10 for this type. [Plot NHMTECRN98SC0003]

Other Vegetation: Other patchy or restricted plant associations were noted on York Island. The southerneastern point had the best development of the Rocky Mountain juniper / indian ricegrass woodland (Juniperus scopulorum /Oryzopsis micrantha Woodland; JUNSCO/ORYMIC) on the steep, north-facing slope of a small hill. Small patches of western snowberry shrubland (Symphoricarpos occidentalis Shrubland) are confined to swales and drainage courses. Sandy ridgetops at the north end have prairie sandreed – sun sedge (Calamagrostis longifolia – Carex inops), and the drainage courses graded in places into the western wheatgrass – green needlegrass grassland (Pascopyrum smithii - Nasella viridula Herbaceous Vegetation).

Most of the perimeter was ringed by sparsely-vegetated shoreline flats of shale fragments colonized by yellow sweetclover (*Melilotus officinalis*), pummeled by the waves and pounded into rack lines that set off backwater wetlands in what were previously bays. These backwater wetlands are colonized and variably dominated by adventive and exotic species like common sunflower (*Helianthus annuus*), tumbleweed (*Amaranthus albus*), (Powell's amaranth (*Amaranthus powellii*), red orache (*Atriplex rosea*), slimleaf goosefoot

(*Chenopodium leptophyllum*), and Russian thistle (*Salsola kali*). The shoreline is interrupted by scattered, high cutbanks.

OVERALL BIODIVERSITY SIGNIFICANCE:
York Island is a small but representative example of the Missouri River Breaks segment of the Great Plains biome. As such, it affords a rangeland reference area for land managers and ecology researchers. The island is small and vertical relief is limited, and though there are two or three major substrate types, overall biological diversity of the uplands is limited.

The survival of Hotsprings Phacelia (*Phacelia thermalis*) on York Island is confirmed, restricted to relatively sparse, successional vegetation zones created by the Fort Peck Reservior; including scoured beaches and the drawdown zone in wetland backwaters. Places where Montana rare plant species of special concern are confined to zones of man-made disturbance raise questions whether the disturbance mimics natural habitat conditions or the species is adventive by nature. One other collection of this species has been made on the Refuge, in Douglas-fir habitat near the former Slippery Anne Guard Station (E0#001), suggesting that the species occupies natural habitat elsewhere and the York Island disturbance may mimic natural habitat conditions. The Refuge is the only place where this species occurs on public land in Montana, and even though York Island does not have biodiversity significance as a representative site for this species' conservation, it points to the possibility of finding such sites elsewhere on the Refuge.

OTHER VALUES:
York Island is also a Fort Peck Reservior landmark and shelter for boaters. Archeological artifacts may be present. Wildlife values were not evaluated.

LAND USE:
This landscape has been grazed in the past and the *Juniperus scopulorum* woodland was probably cut for fencing/firewood. *Juniperus scopulorum* stem density probably approaches pre-disturbance conditions. No signs of grazing were evident. It is otherwise idle except for occasional visits by passing boaters.

MANAGEMENT COMMENTS:
Exotic species present included Canada thistle (*Cirsium arvense*) at scattered shoreline and backwater locations, and minor upland populations of cheatgrass (*Bromus tectorum*) and Japanese brome (*Bromus japonicus*). Yellow sweetclover (*Melilotus officinalis*) dominates beach vegetation where it may interfere with shoreline bird use, and forms dense populations in limited upland areas. It is currently the most abundant non-native species and may have the potential to occupy virtually all habitats on the island, with or without disturbance, as evidenced by its mainland patterns of distribution.

Lake Mason National Wildlife Refuge

Lake Mason Research Natural Area

ENVIRONMENT:
Lake Mason RNA is in a broad, open natural basin, comprised of two parcels totaling 1,420 acres, lying on either side of Lake Mason at the lake perimeter. The lake outlet is South Willow Creek, and it has a spillgate to artificially maintain lake levels. Lacustrine deposits and alluvium derived from shale and sandstone are the primary parent materials in the basin, though residuum derived soils occur in the western half of Section 22. All soils appeared to have a heavy texture, with silty clays and silty clay loams predominant. The semi-arid continental climate has peak precipitation in June followed by May, and a mean annual precipitation of 12.4 inches (Climate data from Roundup, Western Regional Climate Center, 1914-1997). This RNA occurs within the Montana Sedimentary Plains Subsection of the Powder River Basin Section where annual precipitation ranges from 11 to 14 inches annually, about a third of which is snow.

VEGETATION:
The three main vegetation types are distributed primarily according to soil moisture regimes, which vary with distance from Lake Mason and South Willow Creek with the exception of the uplands in Section 22. All but the standing water (herbaceous emergent) plant communities were sampled.

Pascopyrum smithii Herbaceous Vegetation
[PASSMI]
western wheatgrass wet meadow

The extensive alluvial flats are dominated by western wheatgrass (*Pascopyrum smithii*). There are at least six plant associations named across the Northern Great Plains that have *Pascopyrum smithii* as the first-named indicator species; only the type named here is defined by the virtual monospecific dominance of *P. smithii* and is rated G3G5 by TNC. This type is typically strongly associated with subirrigated alluvial flats and most of this plant association in the RNA meets definitions of jurisdictional wetland (Hansen et al. 1995). Consistent with this characterization, both sample plots displayed gleyed and mottled soils. It is dominated by a sward of *P. smithii* ranging in cover from 50 to in excess of 80 percent, making up a relatively homogeneous expanse on the flats (and beyond) around the perimeter of the lake. At least in the sampled locations, weedy or increaser with disturbance species, e.g. Japanese brome (*Bromus japonicus*), povertyweed (*Iva axillaris*), wild lettuce (*Lactuca canadensis*), flixweed tansymustard (*Descurainia sophia*), and common dandelion (*Taraxacum officinale*) dominate the herbaceous layer to the near exclusion of native species except grasses. This may reflect a history of heavy grazing by livestock. [Plots NHMTECLM97SC0001, NHMTECLM970006]

Pascopyrum smithii – Nasella viridula
Herbaceous Vegetation
[PASSMI – NASVIR]
western wheatgrass – green needlegrass grassland

This association is the prevailing type on non-wetland alluvial flats and on gentle upland slopes; it constituted a major plant association prior to agricultural development. It is ranked as G4 and occurs in North Dakota, South Dakota, Wyoming, and Saskatchewan. Stands on the flats grade to the western wheatgrass wet meadow (*Pascopyrum smithii* association) and those of the uplands grade to western wheatgrass- needle-and-thread grassland (*Pascopyrum smithii / Stipa comata*) of drier sites. In the vicinity of South Willow Creek this type appeared to be in good to excellent condition with *Nassella viridula* (green needlegrass) canopy cover ranging from 10 to 40 percent, exceeded only by that of *Pascopyrum smithii*. The uplands in northwest corner of Section 22 also support fair to good quality occurrences of this type. Other graminoids represented with more than 5 percent cover include needle-and-thread (*Stipa comata*) and prairie junegrass (*Koeleria macrantha*). Exotic graminoids, including Japanese brome (*Bromus japonicus*), crested wheatgrass (*Agropyron cristatum*), and Kentucky bluegrass (*Poa pratensis*), are much less prevalent than on the association described above. In the curtailment of grazing, populations of *Bromus japonicus and Agropyron cristatum* often decline, but *Poa pratensis* has shown a propensity on similar mesic sites to increase without disturbance. Povertyweed (*Iva axillaris*) and scarlet globemallow (*Sphaeralcea coccinea*) are the only forbs occurring with more than trace coverages; other high constancy herbs include prickly pear (*Opuntia polyacantha*), American vetch (*Vicia*

americana) and Holboell's rockcress (*Arabis holboellii*). Fringed sage (*Artemisia frigida*) is the only shrub-like plant consistently present; however, it does not exceed 3 percent in canopy cover. [Plots NHMTECLM97SC0003, NHMTECLM97SC0004]

Sarcobatus vermiculatus / *Pascopyrum smithii* Shrubland
[SARVER / PASSMI]
black greasewood / western wheatgrass shrubland

This is a common type on the RNA, especially extensive on the eastern side of the lake where it occurs upslope by a matter of a few tenths of a foot or more from the PASSMI alluvial flat type. These sites are more salt-affected than those with *Pascopyrum smithii* alone. This type as found in a lacustrine setting typically develops under conditions in which salts from alkaline lakes are deposited by wind and water on the leeward shores. The deposition process and probably other habitat conditions are altered by the artificially maintained water levels on Lake Mason. Black greasewood (*Sarcobatus vermiculatus*) occupies slightly raised mounds, perhaps as a result of an ensuing erosion processes. Its canopy cover is low, varying between 5 and 20%, but the visual aspect is that of shrubland due to the stature of the *Sarcobatus vermiculatus* relative to that of the associated undergrowth. This association in the RNA has been as affected by grazing as those of the PASSMI type judging by the dominance of increaser species, foremost among which are Japanese brome (*Bromus japonicus*) and povertyweed (*Iva axillaris*). We noted a micro-patterning within this type as the dense patches of *Bromus japonicus* seemed to have little *Pascopyrum smithii* and conversely where tillering of *P. smithii* was especially dense there was little *B. japonicus*. This is not a high-quality occurrence of this type due to the altered environment and abundance of weeds. [Plot NHMTECLM97SC0002]

Atriplex gardneri / *Pascopyrum smithii* Dwarf Shrubland
[ATRGAR / PASSMI]
Gardner's saltsage / western wheatgrass dwarf shrubland

This association occurs as small stands that are fractions of an acre, across salt-affected alluvial/lacustrine flats on the west side of Lake Mason. These sites undoubtedly have standing water during spring runoff and are slow to dry given the clay soils. At least one site had mottled and incipiently gleyed soil, indicating an oxygen depleted condition developing during extensive inundation. Canopy cover of Gardner's saltsage (*Atriplex gardneri*) is typically not greater than 20 % and usually exceeded by that of a suite of graminoids whose cover contributions are quite variable, including western wheatgrass (*Pascopyrum smithii*) as usual dominant, meadow barley (*Hordeum brachyantherum*), foxtail barley (*Hordeum jubatum*), bottlebrush squirreltail (*Sitanion hystrix*), and Nuttall's alkaligrass (*Puccinellia nuttalliana*). Graminoid cover is higher for the Lake Mason examples than has been seen elsewhere for this association and probably reflects the relatively favorable soil moisture of these sites. The herbaceous component is dominated by weedy species or ones that increase with disturbance, including povertyweed (*Iva axillaris*), clasping pepperweed (*Lepidium perforatum*), wild lettuce (*Lactuca canadensis*), and common dandelion (*Taraxacum officinale*). The suite of weeds/increaser species indicates past disturbance and decreases the baseline value of these sites. [Plot NHMTECLM97SC0005]

Emergent Wetlands: We did not sample the semi-permanent emergent wetlands that are part of the RNA. They are dominated by hardstem bulrush (*Scirpus acutus*) with abundant sago pondweed (*Potamogeton pectinatus*), chara (*Chara* spp.), and water buttercup (*Ranunculus* spp.).

OVERALL BIODIVERSITY SIGNIFICANCE:
The Lake Mason RNA represents a fair example of the western wheatgrass wet meadow (*Pascopyrum smithii*), and a once common plant association, *Pascopyrum smithii-Nasella viridula* with isolated areas in good condition. There are also weed infested occurrences of a less common type (PASSMI alluvial bottom) as well as several associations (SARVER / PASSMI, ARTGAR / AGRSMI) of more restricted occurrence also plagued by weeds. We are not prepared to address the affects of elevated water table levels to this low-lying RNA. In comparison with Mullan Trail RNA and its glaciolacustrine setting, it protects more plant associations and more of the hydrological gradient, though the overall ecological condition is not as high. The RNA is contiguous in places with surrounding grasslands connecting to the larger landscape of the surrounding basin slopes.

LAND USE:
Lake Mason was intensively grazed in the past. Livestock grazing ceased in 1980.

MANAGEMENT COMMENTS:
This RNA may be suited to study of community succession and habitat values with and without restoration practices. The elevated water levels may affect restoration potential and efforts to simulate the historical ecological drivers of grazing and fire.

Big Island Research Natural Area

ENVIRONMENT: Big Island RNA is the second largest of two major islands in Medicine Lake at 251 acres. It has a knoll on the south end that rises 35 ft. above the lake, and two distinct wetland swales north of the knoll, but most of the island is less than 10 feet above lake level and gently rolling. A large bay at the south end is set off by two long isthmuses that are at or below the lake water level and covered mainly by robust grasses. The island is mapped as Blanchard fine sand, 4-20% slope (Richardson and Hanson 1977) though most of the island soils appear to be loamy sands; possibly with glacial till on the knoll at the south end. The controlled lake level affects the island shore, regulated at the Lake Creek outlet, with a dam and spillgate to artificially maintain lake levels. The semi-arid continental climate has peak precipitation in June followed by July and May, and a mean annual precipitation of 13.25 inches (Climate data from Medicine Lake, Western Regional Climate Center, 1911-1997).

Note: This area and two others in Medicine Lake are part of the 11,366 acres designated as Medicine Lake Wilderness Area.

VEGETATION:
The array of plant communities forms a grassland-shrubland mosaic. It can be explained by both small-scale relief as evidenced in height above the lake level, which need vary only a fraction of a foot in order to influence vegetation, and by soil texture. See Figure 2 for an occurrence map of Big Island vegetation types.

Symphoricarpos occidentalis Shrubland
[SYMOCC]
western snowberry shrubland

Western snowberry shrubland constitutes the most extensive vegetation type on the island and is among the most common shrub communities in the Northern Great Plains. Across the island it occurs on gently undulating topography and swales, some of which may be seasonally inundated, intermittently flooded, or subirrigated via subsurface connection to Medicine Lake. It has been characterized in regional classifications as a "temporarily flooded" system, but this is the case on Big Island only when ground thaw is delayed. As noted by Hansen et al. (1995) and exemplified on Big Island, it spans an environmental range from mesic upland slopes to wetlands (hydric soils and wetland hydrology). Almost none of the sites in the RNA would qualify as jurisdictional wetlands because the dominant, western snowberry (*Symphoricarpos occidentalis*), and all associated species including western wheatgrass (*Pascopyrum smithii*), smooth brome (*Bromus inermis*), and Kentucky bluegrass (*Poa pratensis*) are rated FACU (Facultative Upland, i.e. only occurring in wetlands less than 33% of the time and conferring no wetland status) by the U. S. Fish and Wildlife Service.

This type has nearly continuous cover of *Symphoricarpos occidentalis*, a shrub that produces sucker shoots emanating from stout, spreading rhizomes. Given the density of *Symphoricarpos occidentalis*, it is perhaps not surprising that the only other native species found with regularity are also rhizomatous (mentioned above). Weedy species such as flixweed tansymustard (*Descurainia sophia*), pinnate tansymustard (*Descurainia pinnata*), and leafy spurge (*Euphorbia esula*) occur in patches, perhaps areas formerly disturbed. The *Euphorbia esula* is widespread on the island in these relatively moist communities and appears to be expanding, forming dense clones. Several species of spurge fleabeetles have been introduced on the island to provide leafy spurge control.

Ordinarily *Symphoricarpos occidentalis* shrubland occurs in small stands rather than as a prevalent vegetation feature. It is recommended that recent aerial photographs of the island be compared with historic photos if it is possible to determine from them whether shrubland has been present since early years of Refuge establishment. A literature review and dialogue with other refuges of species' management responses and wildlife benefits or deterrents might also be helpful in applying current vegetation information to wildlife management and noxious weed management matters.

Stipa comata - Bouteloua gracilis – Carex filifolia
Herbaceous Vegetation
[STICOM – BOUGRA – CARFIL]
needle-and-thread – blue grama – threadleaved sedge
grassland

This grassland association is found on soils ranging from sandy loam to fine sand. It occurs on Big Island across higher ground and warmer exposures. It is dominated by needle-and-thread (Stipa *comata*), usually having greater than 40% canopy cover. Blue grama (*Bouteloua gracilis*) and threadleaved sedge (*Carex filifolia*) are consistently present, often as co-dominants. Their cover can exceed that of *Stipa comata* and varies greatly across the landscape with no obvious correlation to site factors, whether due to disturbance patterns, imperceptible environmental disturbances, or chance. This type usually grades to grasslands dominated by western wheatgrass (*Pascopyrum smithii*) including PASSMI – CARFIL or PASSMI – BOUGRA. While western wheatgrass is consistently present in this prevailing association, it has low cover values. Forbs are a minor component; only pricklypear (*Opuntia polyacantha*) consistently occurrs in more than trace amounts, favored by the sandy substrates or else the land use history. Fringed sage (*Artemisia frigida*) is consistently present, but seldom exceeds trace amounts. This community type generally has only minor populations of weedy or exotic species; for example, crested wheatgrass (*Agropyron cristatum*) occurs in scattered blocks. STICOM – BOUGRA – CARFIL is a prevailing grassland association of the Northern Glaciated Plains where medium- to coarse-textured soils are found, as previously described for Spring Creek RNA. [Plot MTNHECRA97SC0007]

Pascopyrum smithii – Bouteloua gracilis – Carex filifolia
Herbaceous Vegetation
[PASSMI – BOUGRA – CARFIL]
western wheatgrass – blue grama – threadleaved sedge grassland

This is an uncommon grassland association on the island because fine-textured soils are limited. Western wheatgrass (*Pascopyrum smithii*) is typically the dominant graminoid in this grassland association, but narrowleaved sedge (*Carex stenophylla*; synonym: C. *eleocharis*) was the dominant graminoid (50% c.c.) in the one island plot. Only two shrub-like plants, fringed sage (*Artemisia frigida*) and broom snakeweed (*Gutierrezia sarrothrae*), regularly occur but with low cover values. Rush skeletonweed (*Lygodesmia juncea*), American vetch (*Vicia americana*), pricklypear (*Opuntia polyacantha*) and scarlet globemallow (*Sphaeralcea coccinea*) are the forbs with high constancy but seldom do their coverages exceed 1 or 2% under natural conditions. The occasional bunch of crested wheatgrass (*Agropyron cristatum*) and patch of flixweed tansymustard (*Descurainia sophia*) indicate past disturbance. [Plot NHMTECRA97SC0008]

Hansen and Hoffman (1988) recognize this type by the dominance of *Pascopyrum smithii* over *Stipa comata* and generally this occurs only on lower positions in this landscape or those having planar surfaces and/or having finer-textured soils. Where *Pascopyrum smithii* and *Stipa comata* are co-dominant, or nearly so, we have assigned these sites to PASSMI – BOUGRA – CARFIL due to the appreciable cover of *Pascopyrum smithii* indicating the higher moisture status of these sites (technically, several examples of this community with *Carex* spp. dominant do not "key out" to any type). Note that Schneider et al. (1997) in the provisional Great Plains vegetation classification of The Nature Conservancy, recognize a *Pascopyrum smithii – Stipa comata* community type but cite no parameters for its recognition. The whole complex of community types involving *Pascopyrum smithii, Stipa comata, Carex filifolia, Carex stenophylla, Bouteloua gracilis*, and *Nasella viridula* needs extensive work to separate intrinsically different environments from disturbance induced states and a workable key for discriminating types one from another. This, too, is a broadly distributed Northern Great Plains plant association (CO, MT, ND, SD, SK, WY).

Figure 2.

Vegetation of Big Island RNA
Medicine Lake NWR

Shrub Communities

- 1 Symphoricarpos occidentalis
- 1a Symphoricarpos occidentalis (Bromus inermis)
- 1b Symphoricarpos occidentalis (Euphorbia esula)
- 2 Symphoricarpos occidentalis (Agropyron smithii)
- 2a Symphoricarpos occidentalis (Prunus virginiana)
- 3 Symphoricarpos occidentalis (Distichlis stricta, Euphorbia esula)
- 4 Symphoricarpos occidentalis (Spartina pectinata)
- 5 Prunus virginiana
- 5a Prunus virginiana (Symphoricarpus occidentalis)
- 6 Sarcobatus vermiculatus (Prunus virginiana, Agropyron cristatum)
- 7 Sarcobatus vermiculatus (Agropyron cristatum, Hordeum jubatum, various exotics)

Grassland Communities

- 8 Agropyron smithii-Stipa Comata
- 8a Agropyron smithii-Stipa comata (Calamovilfa longifolia-Agropyron smithii)
- 9 Agropyron smithii-Stipa comata-Bouteloua gracilis
- 10 Distichlis stricta
- 11 Juncus balticus-Carex praegracilis
- 11a Juncus balticus-Carex praegracilis (Poa pratensis)
- 12 Spartina pectinata (Phragmites communis)

Disturbed Communities

- 13 Bromus inermis
- 14 Bromus inermis-Agropyron cristatum
- 15 Descurainia sophia (Pelican damage)
- Unkown Plant Communities
- Beach
- Water
- Ephemeral water

At the given map scale not all community or dominance types can be effectively mapped which necessitates multiple labels and designations of inclusions. Brackets enclose community types or species that consitute in canopy cover up to 20% of a polygon; of polygons labeled as having two community types the first listed is the more extensive and separated from the lesser by a colon. Forward slashes (/) or dashes (-) separate the constituent species by which a plant community or association is named.

Vegetation map units from 8":1 mile (1:7920) aerial photography. Field verified June,1997. Albers Equal Area Projection Datum NAD27.

Montana Natural Heritage Program, 1515 East Sixth Ave, Helena, MT 59620

Other Vegetation Types: In the lost portions of the landscape where the water table is shallow, subirrigated conditions are found. In such settings with soils that are salt-affected, inland saltgrass (*Distichlis spicata*) forms extensive and nearly pure communities or occurs in various mixes with Nuttall's alkaligrass (*Puccinellia nuttalliana*), prairie cordgrass (*Spartina pectinata*) or scattered black greasewood (*Sarcobatus vermiculatus*). Another wetland association of Baltic rush – clustered field sedge (*Juncus balticus – Carex praegracilis*) occurs in alkaline habitats as stringers or small patches that are a few tenths of an acre. Kentucky bluegrass (*Poa pratensis*) often establishes and outcompetes the natives in this habitat. Wet areas that are not so salt-affected have *Spartina pectinata* dominant, with or without an abundance of common reed (*Phragmites communis*).

On the island's west shore there is a mix of woody species and communities that may be more a result of past, or ongoing, disturbance than any intrinsic site differences. Associated with near-shoreline locations and ostensibly subirrigation are several stands of common chokecherry (Prunus virginiana), some serving as nesting sites and perches for black-crowned night herons. They have a margin and sometimes a low-shrub layer of western snowberry (Symphoricarpos occidentalis) and herbs that are mainly non-native grasses. Also present is a band of black greasewood (Sarcobatus vermiculatus), largely dominated by exotics such as Agropyron cristatum or opportunists such as Hordeum jubatum and H. brachyantherum. This vrgetation type is usually present only on the shores of alkali lakes, perhaps reflecting the original nature of Medicine Lake.

On the sandiest substrates associated with needle-and-thread (Stipa comata)-dominated communities were fragments of associations codominated by prairie sandreed including Calamovilfa longifolia – Carex stenophylla and Calamovilfa longifolia – Pascopyrum smithii plant associations. These were too small to map other than noting as inclusions. The abruptness of the transition between the Stipa- and these small Calamovilfa-dominated communities was noted with no discernible soil or other enviromental differences to account for the pattern.

Some of the most heavily-used wildlife habitat has no associated native vegetation. The places of concentrated nesting by the American white pelican colony shifts over time, and the history of use has created areas with extensive bare ground and patches of annuals/biennials, often dominated by flixweeds (*Descurainia sophia* and *D. pinnata*.)

Two Montana plant species of special concern were documented on Big Island. Site information is presented on the Element Occurrence Records in Appendix E, and annotated illustrations are in Appendix F.

Hairy four o'clock (*Mirabilis hirsuta*) is represented by widely scattered plants in very low numbers at different ends of the island, among plant associations dominated by both prairie sandreed (*Calamovilfa longifolia*) and needle-and-thread (*Stipa comata*). It has the lack of habitat specificity on Big Island and in the Sandhills that is characteristic of adventive species. While it is only known from 3 different counties in Montana, there have been reports that it is adventive and more common than records indicate. This study lent support to the case for moving it off to the watch list.

Plains phlox (*Phlox andicola*) occurs on the north-facing slopes of the knoll on Big Island. It is likely to be scattered across most of this slope, but the species was at the very end of flowering at the time of visit, so it could not reliably be located to determine population numbers and extent. It, too, is present on the Medicine Lake Sandhills. In general, it is restricted to sandy soils and was previously known in Montana only from southeastern counties. The numbers of records in recent years provides the basis for changing its state rank from S1 to S2 (potentially imperiled); this rank is subject to review with additional fieldwork in early summer.

OVERALL BIODIVERSITY SIGNIFICANCE:
Big Island RNA supports a spectrum of community types, from slivers of typical prairie wetlands with *Spartina pectinata* and *Distichlis stricta* to dry prairie and to tall shrub copses. This community diversity affords a wildlife habitat diversity, even if the plant associations are not rare or in noteworthy condition. The complex mosaic of communities may not representative of the distribution of these communities in the local landscape due to the regulated
lake water level.

Wildlife values were not evaluated, though it has previously been noted that Big Island harbors nesting subpopulations of piping plovers, federally listed as threatened, a population of black-crowned night herons and a large colony of American white pelicans, both of which are state species of special concern. It is productive for waterfowl and sharp-tailed grouse nesting. Big Island directly contributes to the core waterfowl production mandate, as well as providing habitat for colonial nesting birds. It is one of two major

islands in the lake, and among the few large islands in the Prairie Pothole landscape of northeastern Montana, particularly important in reducing mammalian predation.

LAND USE HISTORY:
The island was not previously contiguous with the mainland, but livestock were brought out prior to Refuge establishment. The vegetation-altering affects of grazing history compared to raised water levels and colonial bird use were not evaluated. Whatever the cause(s), there are areas that are covered by nothing but the exotic grasses *Bromus inermis* (smooth brome) and quackgrass (*Elymus repens*) to the extent that native communities are not identifiable. Usually where these grasses have invaded native communities, there are vestiges of the native communities.

MANAGEMENT COMMENTS:
Threats are posed to this whole landscape by exotics and noxious weeds. Leafy spurge (*Euphorbia esula*) is by far the most aggressive and tenacious of noxious weeds, and is well established. It has a strong presence in the southern end of the island. Several species of spurge fleabeetles are established on the island (Rabenberg pers. commun.) Their potential for curbing seed production is particularly important because the seeds of leafy spurge are readily disseminated by water and wildlife vectors as whitetail deer and mourning dove.

The far north and south ends have much Canada thistle (*Cirsium arvense*). Smooth brome (*Bromus inermis*), quackgrass (*Elymus repens*), and crested wheatgrass (*Agropyron cristatum*) are also present throughout the island. *Bromis inermis* appears to be aggressively displacing *Pascopyrum smithii* from *Symphoricarpos occidentalis- and Pascopyrum smithii*-dominated communities. Other common exotic grasses include cheatgrass (*Bromus tectorum*), Japanese brome (*Bromus japonicus*), fowl bluegrass (*Poa palustris*) and Kentucky bluegrass (*Poa pratensis*).

Exceptionally high litter accumulation levels were noted over most of the Island in both grassland and shrubland habitat. As mentioned previously, it is possible that the extensive shrub cover of *Symphoricarpos occidentalis* is an artifact of the land being left idle. This same shrubland type is present in trace amounts in Tepee Hills RNA, and though the two sites have different settings and substrates, they have some comparative value. The management options for addressing these situations depends on desired vegetation structure for wildlife and the framework for integrating noxious weed management.

Bruce's Island Research Natural Area

ENVIRONMENT:
Unlike Big Island, which is mostly low-lying terrain, Bruce's Island is a ridgeline that had once been connected to the mainland, made up of a hump and toeslopes together totaling 367 acres. It has little of the microtopography patterns as found on Big Island. The high shores on the north are eroding in places as cutbanks, and the gentle toe slopes on the south are temporarily inundated. Soils are mapped as Dooley fine sandy loams on the high north end, Dimmick silty clay in a low-lying middle band, and Williams loam, undulating at the south end (Richardson and Hanson 1977). The controlled lake level affects the island shore, regulated at the Lake Creek outlet, with a dam and spillgate to artificially maintain lake levels. The semi-arid continental climate has peak precipitation in June followed by July and May, and a mean annual precipitation of 13.25 inches (Climate data from Medicine Lake, Western Regional Climate Center, 1911-1997).

Note: This area and two others in Medicine Lake are part of the 11,366 acres designated as Medicine Lake Wilderness Area.

VEGETATION:
Approximately one half of Bruce's Island on the higher elevations of the north has been plowed. In this area, as well as unplowed uplands, *Agropyron cristatum* (crested wheatgrass) is the prevailing cover type. As a whole, the uplands have been sufficiently altered so that they no longer support intact native vegetation, instead reduced to small, irregular patches of native species among the exotics. The potential prevailing matrix community type of the uplands is probably western wheatgrass – blue grama – threadleaved sedge grassland (*Pascopyrum smithii – Bouteloua gracilis – Carex filifolia* Herbaceous Vegetation) or western wheatgrass – needle-and-thread *grassland (Pascopyrum smithii – Stipa comata* Herbaceous Vegetation). Sample plots were not established in the course of field reconnaissance of this RNA because of the lack of intact vegetation.

The lower lying terrain on the island's southern portion, particularly along the shorelines, has well-developed palustrine emergent vegetation. Inland saltgrass (*Distichlis spicata*) is among the most extensive wetland vegetation types, occurring predominantly as a broad ecotone between wetter sites dominated by bulrush (*Scirpus* spp.) or alkali cordgrass (*Spartina*

gracilis) and uplands. In some locations salt efflorescence was noted in the *Distichlis spicata* flats, indicating it exists along the capillary fringe of wetland sites. Alkali bulrush (*Scirpus maritimus*), hardstem bulrush (*Scirpus acutus*), and sharp bulrush (*S. pungens*) dominate the communities at the shoreline fringes in positions that are nearly continuously flooded. Prairie cordgrass (*Spartina gracilis*) was noted in shoreline patches. The Baltic rush –clustered field sedge meadow (*Juncus balticus-Carex praegracilis* Emergent Vegetation) is found on wetland sites that appear to be only temporarily or intermittently flooded. Where disturbance occurs in this vegetation, American licorice (*Glycyrrhiza lepidota*) can be an important component. Canada thistle (*Cirsium arvense*) is scattered in with the *Glycyrrhiza lepidota* and has patches of abundance in the *Symphoricarpos occidentalis* Shrubland where it forms a discontinuous and narrow fringe between true wetland sites and upland grasslands. There are also gentle mudflats and a small bay on the eastern shore.

OVERALL BIODIVERSITY SIGNIFICANCE:
There are no intact upland plant associations represented on Bruce's Island. In the southern portion of the island there are typical Northern Glaciated Plains Section wetlands types represented. These wetland types may be more appropriately sought as RNA targets among natural wetland basins, and it is expected that they are represented elsewhere on the refuge system in Montana.

Wildlife values were not evaluated. It has previously been documented that Bruce's Island harbors nesting subpopulations of piping plovers, federally listed as threatened. It is said to be productive for waterfowl and upland game bird nesting, as well as harboring significant numbers of Baird's sparrows and grasshopper sparrows. Site biodiversity significance may hinge on the contribution of Big Island avifauna to the Medicine Lake landscape as a whole. The artificially maintained lake levels ensure the isolation of Bruce's Island as an island, directly contributing to the core waterfowl protection mandate. It is one of two major islands in the lake, and among the few large islands in the Prairie Pothole landscape of northeastern Montana.

LAND USE:
Bruce's Island is covered by a tamegrass planting or "goback" of crested wheatgrass (*Agropyron cristatum*) over the higher northern half of the island, and has been grazed in the past. It has been an island since lake levels were raised.

MANAGEMENT COMMENTS:
The site has limited potential to serve as a natural area ecology/botany baseline despite its wildlife values

Homestead Research Natural Area

ENVIRONMENT:
The Homestead RNA is a 39 acre tract on a gently-rolling glacial till deposit above the mouth of Lake Creek on Big Muddy Creek. Soils are a mixture of Bowdoin and Lohler clay loams in the northwest corner, with Manning coarse sandy loam along the eastern margin (Richardson and Hanson 1977). The semi-arid continental climate has peak precipitation in June followed by July and May, and a mean annual precipitation of 13.25 inches (Climate data from Medicine Lake, Western Regional Climate Center, 1911-1997).

VEGETATION:
The grassland is unbroken but heavily invaded or seeded into smooth brome (*Bromus inermis*) and quackgrass (*Elymus repens*). The closest semblance to a natural plant association is composed of small, weedy patches of western wheatgrass - blue grama grassland (*Pascopyrum smithii – Bouteloua gracilis* Herbaceous Vegetation). Sample plots were not established in the course of field reconnaissance of this RNA because of the lack of intact vegetation.

OVERALL BIODIVERSITY SIGNIFICANCE:
The RNA was originally designated in recognition of its value as a lek for breeding sharptail grouse, as well its reported vegetation features. Wildlife values were not evaluated.

LAND USE:
There are abandoned quarry sites present. The name for the area comes from the nearest town called "Homestead." The site is bordered by roads on two sides, with deep ditches to drain water from the roadbed, lowering the water table. Cottonwood trees have become established in the ditch on the western margin.

MANAGEMENT COMMENTS:
The site has limited potential to serve as a natural area ecology/botany baseline despite its wildlife values.

MEDICINE LAKE SANDHILLS
(PART OF MEDICINE LAKE WILDERNESS AREA)

ENVIRONMENT:
The Medicine Lake Sandhills are of recent Holocene geological development, formed when prevailing winds from the northwest scoured sediments from dried Pleistocene lake beds. The lacustrine beds contained all particle size classes. Silt and clay fractions were carried far downwind but the sand-sized particles were deposited immediately to the southeast, and partially reworked by the winds to form sand dunes. Much of the landscape is rolling but portions have typical choppy dune features, with blowouts and associated stages of dune stabilization. Not all of the springs and seeps were developed for livestock use, and they contribute significantly to species and habitat diversity. The semi-arid continental climate has peak precipitation in June followed by July and May, and a mean annual precipitation of 13.25 inches (Climate data from Medicine Lake, Western Regional Climate Center, 1911-1997).

Note: This area and two others in Medicine Lake are part of the 11,366 acres designated as Medicine Lake Wilderness Area. This report is a very preliminary description of the refuge portion (about 2,300 acres of the Wilderness Area) of the entire sandhills area that in the aggregate covers about 21 square miles, the largest dune complex in Montana.

VEGETATION:
The sandplains and sand dunes harbor community types that are possibly unique in Montana, underdocumented, and pending classification review in the northern Great Plains states and provinces. The landscape is primarily composed of graminoid-dominated vegetation, especailly in blow-out areas, though in swales and bottomlands shrub-dominated vegetation types are common.

Calamovilfa longifolia – Stipa comata Herbaceous Vegetation
[CALLON – STICOM]
Prairie sandreed (-) needle-and-thread grassland

Stabilized sites constitute the vast majority of the landscape, particularly the more planar areas while the blow-out patches are very scattered. The more stabilized states have high canopy coverages of needle-and-thread (*Stipa comata)* usually in excess of 50%. There are far lesser amounts of the next most prevalent grass, prairie sandreed *(Calamovilfa longifolia)*, with lemon scurf-pea (*Psoralea lanceolata*) as the most common species among a weakly represented forb component (total cover not exceeding 10%). It was tentatively place in the *Calamovilfa longifolia – Stipa comata* Herbaceous Vegetation type (prairie sandreed – needle-and-thread grassland). This plant association may in turn be an early and long-persisting seral stage of to *Stipa comata – Bouteloua gracilis – Carex filifolia* Herbaceous Vegetation, but no examples of the latter were found in either the choppy or the gently rolling terrain. Additional field sampling may be required to adequately describe the plant associations, their relation to successional processes, and the site variables. [Plots NHMTECRA97SC0004, NHMTECRA97SC0005, NHMTECRA97SC0006]

Symphoricarpos occidentalis Shrubland
[SYMOCC]
western snowberry shrubland

Shrubland dominated by western snowberry *(Symphoricarpos occidentalis)* is a recurrent community type within the Sandhills, usually occurring in swales but extending upslope in the area, though with reduced stem density. In the physiognomic portion of the classification it is referred to as a temporarily flooded type which could hardly be the case for the Sandhills sites; there have to be some unappreciated circumstances that favor the establishment of *Symphoricarpos occidentalis* and other shrubs on such seemingly droughty sites. The undergrowth is dominated by western wheatgrass (*Pascopyrum smithii)* and very few herbaceous species (usually fewer than five).

Elaeagnus commutata / Stipa comata Shrubland
[ELECOM / STICOM]
silverberry / needle-and-thread shrubland

This is community type has not been previously named or described. A rare silverberry/western wheatgrass shrubland (*Elaeagnus commutata / Pascopyrum smithii* Shrubland; G2) has been named and cited as occurring in MT, SK, ND, and MB. The combination of *Elaeagnus commutata* and *Stipa comata* is unique in that *Elaeagnus commutata* is usually associated with moist sites in the landscape and *Stipa comata* with drier, sandy soils. Quite possibly the deeper-rooting *E. commutata* is tapping a watertable unavailable to the herbaceous component. This is supported by the fact that common chokecherry *(Prunus virginiana)* and western snowberry *(Symphoricarpos occidentalis)* occur as community dominants adjacent to the *Elaeagnus commutata*-dominated community, ostensibly on the same site.

Both of these other species require moisture in levels above that supplied through precipitation alone or by compensating environments where evaporative losses are mitigated.

The *Prunus virginiana*-dominated community has an undergrowth with *Stipa comata* dominant but with *Pascopyrum smithii* prominent whereas the *Symphoricarpos occidentalis*-dominated communities have an undergrowth with the abundances of these undergrowth species switched (*Stipa comata* relegated to merely present in most cases). It would be difficult to envision a scenario wherein the *Pascopyrum smithii* was grazed out of the ELECOM / STICOM p.a. and not the adjacent *P. virginiana*- and *S. occidentalis*-dominated communiities. In keeping with the sandy substrate, by far the dominant forb in ELYCOM / STICOM was slimleaf scurfpea (*Psoralea lanceolata*); other forbs were present in only trace amounts. Wildlife browsing has been intensive on the *Elaeagnus* with shrubs attaining only 3-3.5 ft. height in 11 to 12 years. [Plot NHMTECRA97SC0003]

In general, *Elaeagnus commutata* is rarely regarded as a shrubland dominant in the south of the 49th Parallel except possibly as a localized feature on limestone, including montane settings, or on well-drained Northern Great Plains grasslands in idle conditions and with ample moisture.

Prunus virginiana Shrubland
[PRUVIR]
common chokecherry shrubland

Common chokecherry (*Prunus virginiana*) dominates very small stands within the Sandhills; the stems had been exceedingly hedged by wildlife browsing and the leaves fed on by insects. The undergrowth has both needle-and-thread (*Stipa comata*) and western wheatgrass (*Pascopyrum smithii*) as dominants, their roles apparently shifting by site. This type is found primarily on the undulating flats but also occurs on slopes of arrested dunes, sites seemingly too dry for a species normally associated with mesic sites. [No Plot]

Oryzopsis hymenoides / *Psoralea lanceolata* Sparse Vegetation
[ORYHYM / PSOLAN]
indian ricegrass / lemon scurf-pea barrens

A recent blowout early in the process of stabilization was sampled that represents an indian ricegrass / lemon scurf-pea barrens (*Oryzopsis hymenoides* / *Psoralea lanceolata* Sparse Vegetation). The unconsolidated sand substrate constitutes over 90 % of the cover at the surface, and the vegetation canopy cover is less than 5 %. This is a fundamentally different vegetation than the Centennial sandhills, but these two sites have one rare plant species in common (*Cryptantha fendleri*) as well as analogous successional processes (Lesica and Cooper 1999).

SPECIES:
Four Montana pant secies of special concern have been documented in the Medicine Lake Wilderness Area; two in the course of this study. Species site information is presented on the Element Occurrence Records in Appendix E, and annotated illustrations are in Appendix F. Detailed information is lacking to compare their numbers in the Refuge to elsewhere on the Sandhills for providing concise statements of botanical significance. Nonetheless, for its habitat uniqueness and accrued botanical information, it represents the highest known concentration of rare plants in the Sandhills and in the county.

Fendler's cat's-eye (*Cryptantha fendleri*) occurs in the Sandhills on discrete zones of unstable sand, often the leeward rim of active dune blowouts. It was found in two of the most active blowouts on the Refuge, perhaps a small segment of a much larger population complex alluded to by Lesica in estimating total plant numbers in excess of 10,000 across the entire Medicine Lake Sandhills.

Schweinitz' flatsedge (*Cyperus schweinitzii*) also occurs on unstable sand, often in the hollow at the head of an active blowout. It was found at a single site on the Refuge, presumable part of a much larger population complex alluded to by Lesica in estimating total plant numbers as "many thousands" across the entire Medicine Lake Sandhills.

Hairy four o'clock (*Mirabilis hirsuta*) is widely scattered in low numbers across a range of sandy habitats. It shows no discernible habitat specificity in relation to composition or structure. It is present in both the Medicine Lake Sandhills and Big Island. It has since been documented outside of the Refuge in disturbed settings including roadsides and CRP. It exhibits the distribution pattern of an adventive species, thus providing the basis for removing it from the list of Montana plant species of special concern to the watch list. Yet it is only known from three counties and seven collection records so that field data will continue to be compiled on it for further evaluation.

Plains phlox (*Phlox andicola*) is locally common on gently rolling sandhill slopes under a sparse canopy of *Elaeagnus commutata* (silverberry) [Plot NHMTECRA97SC0003] where only the vestiges of flowers remained at the time of visit. It was occasional in the best condition grassland habitat of Big Island, as found on a steep, north-facing slope. It may be under-documented in the sandhills area because it is inconspicuous except during its early flowering, but there is not enough information to confirm or refute this idea at present.

OVERALL BIODIVERSITY SIGNIFICANCE:
The Medicine Lake Sandhills are part of the largest sandhills in Montana, followed by the Centennial Sandhills in southwestern Montana which overlaps with Red Rock Lakes NWR. These landscapes, and their dune system in particular, constitute highly significant landscapes, harboring unique plant communties and rare species.

This characterization is at best a preliminary highlight of the sandhills vegetation and rare plant species. Wildlife values were not evaluated.

OTHER VALUES:
Archeological and cultural values are often associated with sandhills.

LAND USE:
The area has a long history of grazing by livestock. Grazing leases were recently cancelled on the area. Upland segments near roads have been planted into crested wheatgrass (*Agropyron cristatum*).

MANAGEMENT COMMENTS:
Widely-scattered patches of leafy spurge (*Euphorbia esula*) have been identified by Refuge personnel (Rabenberg pers. commun.) There are several spurge flea-beetle release sites in the Sandhills.

Prior to the settlement, this landscape was maintained in various successional states by periodic disturbance, mostly via buffalo, pocket gophers, fire and wind. The processes operative here are probably analogous to those within the Centennial Sandhills. Studies have demonstrated for the Centennial ecosystem, that without periodic disturbance and with the healing of existing blow-out and deposition surfaces, the result is reduced community and species diversity, particularly of rare species associated with early seral states (Lesica and Cooper 1999). Cattle have served as surrogate disturbance agents in the Centennial system and in the Medicine Lake Sandhills in some measure. Weed problems could be exacerbated without close control of management and weed population responses.

Portions of the sandhills native communities are overwhelmed by dense populations of increaser species, for example, sagewort (*Artemisia campestris*), brittle prickly-pear (*Opuntia fragilis*), flixweed tansymustard (*Descurainia sophia*), *and* pinnate tansymustard (*D. pinnata*) that may have resulted from past grazing practices. Leafy spurge (*Euphorbia esula*) is present in widely-scattered patches and spurge flea-beetles have been released in an effort to control it (Rabenberg pers. commun.). Canada thistle (*Cirsium arvense*) and other exotic species like smooth brome (*Bromus inermis*), Japanese brome (*B. japonicus*), and crested wheatgrass (*Agropyon cristatum*) are present in low numbers.

Reintroduction of appropriately timed fire may possibly be a management option to consider in containing nearby weeds, reducing litter accumulation, setting back woody species, and stimulating forbs.

The undeveloped areas of natural spring and seep features and associated riparian habitat that were noted are in relatively good ecological condition and are among the segments of the landscape warranting closer investigation. Water developments below them reduced grazing pressure in the hills above.

Tepee Hills Research Natural Area

ENVIRONMENT:
Tepee Hills is developed on a till/outwash plain that has been down-cut by an abandoned meander channel of the Missouri River. It straddles the crest of the slopes above Medicine Lake, with mainly south-facing slopes mapped as Zahill clay loam, steep (Richardson and Hanson 1977) that have overlying gravelly, cobbly water-worked deposits of Flaxville gravel (Witkind 1959). The center of the RNA is dissected by a coulee. The RNA comprises only 50 acres but with the variation in relief, aspect and soil depth, a range of environments are represented. The semi-arid continental climate has peak precipitation in June followed by July and May, and a mean annual precipitation of 13.25 inches (Climate data from Medicine Lake, Western Regional Climate Center, 1911-1997).

VEGETATION:
The variation in aspect, soil depth as it affects water holding capacity, and slope runoff produce a number of distinct environments in a relatively confined area (see Figure 3, Tepee Hills RNA plant communities and associations).

Stipa comata – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation
[STICOM – BOUGRA – CARFIL]
needle-and-thread – blue grama – threadleaved sedge grassland

This is one of the most extensive and broadly distributed of upland plant associations within the Northern Great Plains, occurring in Manitoba, Saskatchewan, Nebraska, Wyoming, North and South Dakota and in Montana is a major matrix type from the base of the Rocky Mountain Front eastward. In the Medicine Lake landscape it is restricted to the most xeric exposures, moderate to steep, south- to southwest-facing, mostly convex slopes having shallow soils. ??Compositionally the RNA examples of this type are not close to the modal description wherein *Stipa comata* is the dominant graminoid and *Bouteloua gracilis* has 100% constancy (but cover values not exceeding 30 %). Quite possibly past grazing, favoring short-statured rhizomatous species, has influenced the composition of this site. [Plot NHMTECRA97SC0001]

Stipa curtiseta – Elymus lanceolatus Herbaceous Vegetation
[STICUR – ELYLAN]
porcupine needle-grass (-) thick-spike wheatgrass grassland

This association is found only on moderate to steep, north-facing slopes with well-developed soils, as restricted to the coulee. It has been described from similar settings in northern Valley and Phillips Counties (DeVelice et al. 1995) and in northwestern North Dakota. However, within the Canadian prairies or prairie parklands it occurs on planar and rolling surfaces as an extensive, prevailing type in mesic settings. In the Tepee Hills representation of this type, porcupine needle-grass (*Stipa curtiseta*) is mono-dominant (in excess of 50 % canopy cover) and other graminoids, including thickspike wheatgrass (*Elymus lanceolatus*) which are said to be dominant or co-dominant in Canadian settings, comprise little more than trace amounts. This suggests the need to further evaluate if not reclassify this plant association. There is a noteworthy and relatively luxuriant diversity of native forbs, reflecting the mesic environment, totaling 36 species in a single plot. They include outlying Rocky Mountain plant species such as small-flowered penstemon (*Penstemon procerus*) that are of biogeographic interest. [Plot NHMTECRA97SC0002]

Pascopyrum smithii – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation
[PASSMI – BOUGRA - CARFIL]
western wheatgrass – blue grama – threadleaved sedge grassland

This is a broadly distributed type Northern Great Plains plant association, which we have distinguished from ELYLAN – STICOM because it appeared to be present lower in the landscape, on the flats and toeslope positions, than was the ELYLAN – STICOM community type. This distinction may be somewhat artificial but their respective distributions appeared distinct at the time of sampling. This type generally occupies heavier soils and more poorly drained sites than does ELYLAN – STICOM. Western wheatgrass (*Pascopyrum smithii*) is the dominant graminoid with cover usually in excess of 40 %; the cover of blue grama (*Bouteloua gracilis*) and threadleaved sedge (*Carex filifolia*) is usually less than that of *Pascopyrum smithii*. Which species has greater cover seems to vary randomly across the landscape. Within this RNA, crested wheatgrass (*Agropyron cristatum*) has established significant coverages in this community type, mostly by volunteer seeding from adjacent agricultural lands. [No Plot]

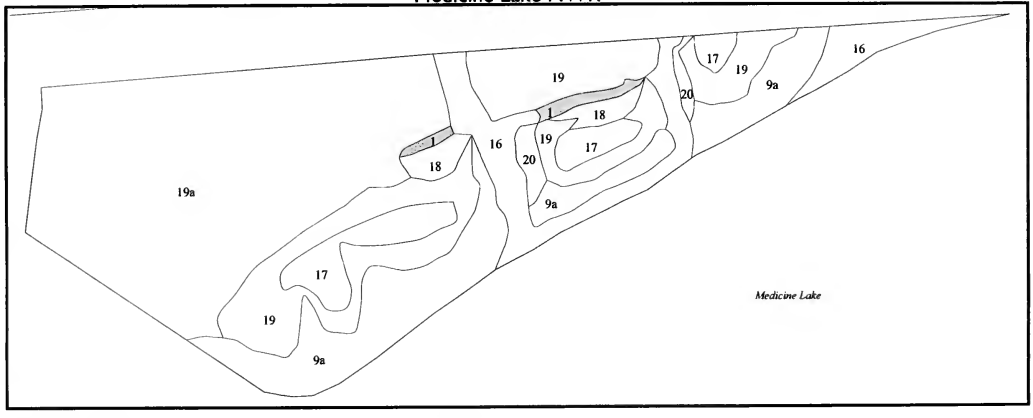
Pascopyrum smithii Herbaceous Vegetation
[PASSMI]
western wheatgrass grassland

This association represents, along with westerm smpwberry shrubland, the most mesic sites within the uplands of the refuge. It is a widely distributed across the Northern Great Plains from Montana to Nebraska and south to Colorado. It occupies, as a narrow band, the heaviest alluvium soils of toeslopes and ephemeral drainages; often this type is assumed to be subirrigated and occasionally it can qualify as a jurisdictional wetland (no examples of this on RNA). In its native state, this type is characterized by virtually

Figure 3.

Vegetation of Tepee Hills RNA

Medicine Lake NWR



Shrub Communities

1 Symphoricarpos occidentalis

Grassland Communities

9a Agropyron smithii-Stipa Comata-Bouteloua gracilis (Agropyron cristatum)

16 Agropyron smithii (Agropyron cristatum, Bromus inermis, Caragana arborescens)

17 Stipa comata-Bouteloua gracilis-Carex filifolia

18 Stipa curtiseta-Elymus lanceolatus

19 Stipa comata-Elymus laceolatus

19a Stipa comata-Elymus lanceolatus (Agropyron cristatum)

20 Agropyron smithii-Stipa viridula

Medicine Lake NWR

Private Land

Water

0.1 0 0.1 0.2

Scale in Miles
Albers Equal Area Projection
Datum NAD27

At the given map scale not all community or dominance types can be effectively mapped which necessitates multiple labels and designations of inclusions. Brackets enclose community types or species that constitute in canopy cover up to 20% of a polygon; of polygons labeled as having two community types the first listed is the more extensive and separated from the lesser by a colon. Forward slashes (/) or dashes (-) separate the coostituent species by which a plant community or association is named.

Vegetation map units from 8":1 mile (1:7920) aerial photography. Field verified June 1997.

June 15, 1998

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Helena, MT 59620

monospecific dominant *Pascopyrum smithii* (coverages generally in excess of 60 %) and low forb diversity. Within the RNA, almost all of these habitats have been either seeded to, or invaded by, *Agropyron cristatum* (crested wheatgrass) and *Bromus inermis* (smooth brome) though *Pascopyrum smithii* has often maintained dominance or co-dominance. [No Plot]

Symphoricarpos occidentalis Shrubland
[SYMOCC]
western snowberry shrubland

This is a common Northern Great Plains type of subirrigated settings or those receiving overland flow, draws and swales, positions that on the RNA are merely mesic uplands and not wetlands or riparian habitat. The RNA examples of this type are small inclusions in more extensive types and are in relatively good condition with the density of western snowberry *(Symphoricarpos occidentalis)* sufficient to exclude most other species except for the rhizomatous grasses like western wheatgrass *(Pascopyrum smithii)*, smooth brome *(Bromus inermis*, and Kentucky bluegrass *(Poa pratensis)*. [No Plot]

OVERALL BIODIVERSITY SIGNIFICANCE:
Tepee Hills has the most intact vegetation overall among the Medicine Lake Refuge's established RNAs, a slice of Great Plains landscape. Perhaps the most significant ecological feature captured by this RNA is the *Stipa curtiseta – Elymus lanceolatus* plant association, a relatively high quality example of what is considered as an important vegetation type of the Canadian glaciated plains. There are no other protected examples of this community documented within the state.

OTHER VALUES:
Tepee Hills has archeological values, featuring a historic Native American encampment, recognized on the National Registry of Historic Places.

LAND USE:
The area was grazed prior to RNA establishment. It has light non-motorized recreational use. It is bordered by a crested wheatgrass planting on the west that may extend within RNA boundaries.

MANAGEMENT COMMENTS:
Tepee Hills is a relatively small area, surrounded mainly by agricultural lands and man-made features that can be expected to provide a continuous threat through weed introductions and simple fragmentation of populations and habitat. It is situated between a CRP planting *of* crested wheatgrass (*Agropyron cristatum*) to the north and a weedy roadside right-of-way to the south. A large area of smooth brome (*Bromis inermis*) has become established on the western end of the ridgetop. Planted windbreak species within the RNA include Siberian pea-shrub (*Caragana arborescens*) and green ash (*Fraxinus pennsylvanica*). It was burned in the spring of 1994 (Rabenberg pers. commun.)

Red Rock Lakes National Wildlife Refuge

Sheep Mountain Research Natural Area

ENVIRONMENT:

Sheep Mountain RNA represents an 85 acre segment of a unique environment both within the USFWS refuge system in Montana and the state at large. The Centennial Range is Montana's only large mountain range whose main axis is oriented east-west. As such, it is in position to intercept cells of moist air that originate in the Gulf of Mexico and drift northward in mid to late summer. These cells are the source of afternoon thundershowers that can be quite intense and can cause mountain meadows to remain green long into the growing season. Annual precipitation at Lakeview (6,700 ft.), in the Centennial Valley at the very base of the mountains, is 20.1 inches, which is quite high for a valley location (compare to Wisdom, MT [6,100 ft elevation] which receives 11.8 in. annually). Near the crest of the range annual precipitation probably exceeds 50 inches. About 27% of annual precipitation falls in May and June, which is typical for western Montana's mountainous areas. Soil, snow, winds, and snow slides also shape its uniqueness, as recognized in the original establishment record. The Sheep Mountain RNA, ranging in elevation from 7,600 to 8,400 ft., is but a partial representation of a 3,000 vertical feet long mountain gradient developed wholly on the calcareous (predominantly Madison limestone) north flank; quartzite is also reported to be present here according to the original establishment record. The limestone-derived soils are generally thin and have a low water holding capacity. An avalanche chute is located along the RNAs north edge.

VEGETATION:

The vegetation features of Sheep Mountain RNA are consistent with Society of American Foresters (SAF) cover type (c.t.) targets originally identified for the site, including the Engelmann spruce-subalpine fir c.t., Interior Douglas Fir c.t., and limber pine c.t. They are in noteworthy old-growth form. In addition, grassland communities and the avalanche chute successional features are present.

Four tree species are the climax dominants in the forest series on Sheep Mountain RNA: Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), Douglas fir (*Pseudotsuga menziesii*) and limber pine (*Pinus flexilis*). In addition, a grassland ridgeline opening is near the lower end toward the east, and an avalanche chute is near the upper end toward the west. The predominantly north-facing slopes of the RNA support plant associations of forest series even at the lowest elevations because of the high precipitation. This is in contrast to other portions of southwestern Montana, where at the elevations represented on this RNA, grasslands are prevalent and any forest series present would be only the *Pseudotsuga menziesii* or *Pinus flexilis* series. High elevation sites that have thin soils, are on wind-exposed or ridgeline positions, or have warmer exposures, regularly support the *Pseudotsuga menziesii* and *Pinus flexilis* series. *Pseudotsuga menziesii*, *Pinus flexilis* and even *P. engelmannii* tend to be favored over *Abies lasiocarpa* and lodgepole pine (*Pinus contorta*) by calcareous substrates. In fact, *Pinus contorta* was rarely seen in the course of our RNA transect, which appeared to traverse only limestone. Thus, these three species, *Pseudotsuga menziesii*, *Picea engelmannii*, *and Pinus flexilis*, tend to have greater cover on these mesic slopes than would be predicted from precipitation and temperature alone. Where thin soils combine with exposed positions and warmer exposures, non-forested environments are produced and usually dominated by bunchgrasses like bluebunch wheatgrass (*Pseudoroegneria spicata)* and/or Idaho fescue (*Festuca idahoensis*).

Abies lasiocarpa / *Thalictrum occidentale* Forest
[ABILAS / THAOCC]
subalpine fir / western meadowrue forest

The vast majority of this RNA is considered to be in various seral stages of this potential or climax plant association. The subalpine fir is used to name the association even though Douglas-fir is strongly dominant in stands representing this type. This naming convention is used because the national vegetation classification, at least in the western United States, has been based, up to now, on plant associations named in the context of potential natural vegetation or habitat types (Pfister and Arno 1980). The existing vegetation or seral associations that occur within habitat types

(potential natural vegetion based associations) are yet to be documented. The area capable of supporting the subalpine fir / western meadowrue forest (*Abies lasiocarpa / Thalictrum occidentale* Forest; ABILAS/THAOCC) ranges from the steep, north-facing slopes at the lowest elevations of the RNA to the upper slopes (7,900 ft. plus) where it extends to warmer slopes as increasing elevation with colder temperatures and increased precipitation compensate for aspect with increased solar insolation load. The ground surface is continuously carpeted with litter, having virtually no stone or gravel exposed. This plant community could be "typed" in two ways, using Pfister et al. 1977 (which is specific to Montana) and Steele et al. 1983 (which is specific to eastern Idaho and western Wyoming); the undergrowth and associated mesic environment better correspond to the ABILAS / THAOCC climax association described in Steele et al. (1983) as a minor type in northwestern Wyoming.

Most of the stands are rather open (verging on woodland at less than 70% canopy cover), not exceeding 65 to 75 ft. in height, single-aged to two-aged and dominated by *Pseudotsuga* in the upper canopy. At least two old-growth stands were encountered, where *Pseudotsuga* exceeding 20 inches and 200 years were common. Though there are occasional mature *Abies* specimens in the upper canopy, *P. engelmannii* is the more common representative of mature to late seral tree species. At the start of reconnaissance from the slope bottom, it was especially notable that virtually all smaller *Abies* projecting above the snowline had been browsed, ostensibly by moose. Given that most of these *Abies* stems were decidedly shorter than they should have been given the thickness of their stems, it is inferred that this snowline browsing has continued for years and is the primary reason these stands will never become *Abies* dominated. Seral *Pinus flexilis* is perhaps the most abundant canopy tree after *Pseudotsuga* and *Picea*.

Undergrowth cover, which varies inversely with the degree of canopy shading, ranges from just barely more than trace amounts to 50% plus and is dominated by forbs; those with the greatest cover and constancy include showy aster (*Aster conspicuus*), western meadowrue (*Thalictrum occidentale*), mountain sweet-cicely (*Osmorhiza chilensis*), heart-leaved arnica (*Arnica cordifolia*), northern valerian (*Valeriana dioica*) and slender cinquefoil (*Potentilla gracilis*). Shrub cover barely exceeds trace amounts; various *Ribes* species (currant or gooseberry) and mountain snowberry (*Symphoricarpos oreophilus*) are regularly present. The grass component is also depauperate with nodding bluegrass (*Poa reflexa*) and pinegrass (*Calamagrostis rubescens*) usually the only species present and always with low cover, usually not exceeding 5%. [Plots NHMTECRN98SC0033, NHMTECRN98SC0035]

Abies lasiocarpa / Juniperus communis Woodland [ABILAS / JUNCOM] subalpine fir / common juniper woodland

This is a very common plant association, identified from the drier mountain ranges of eastern Oregon and Washington, eastward into Montana and Wyoming and south as far as New Mexico and Arizona (see explanation under ABILAS / THAOCC association as to why these stands dominated by Douglas-fir (*Pseudotsuga menziesii*) are named for subalpine fir (*Abies lasiocarpa*). Common juniper (*Juniperus communis*) is a relatively stress-tolerant shrub. Within the context of this relatively mesic, generally north-facing flank of the Centennial Range it represents habitats experiencing greater moisture stress than are reflected by the presence of other forested associations commonly encountered that instead have subalpine fir (*Abies lasiocarpa*) in association with either western meadowrue (*Thalictrum occidentale*), pinegrass (*Calamagrostis rubescens*) or with shiny-leaf spireaea (*Spiraea betulifolia*). On the RNA, ABILAS / JUNCOM was encountered on warmer exposures, those with a westerly component, and above 7,800 ft., though it is capable of occurring at much lower elevations. It generally grades to ABILAS / mountain gooseberry (*Ribes montigenum*), which is present on the RNA as narrow patches where snowpacks are deeper than on surrounding terrain.

Being a woodland, tree canopy cover is generally below 60% and tree form approaches "stunted" with heights barely exceeding 40 feet at more than 350 years of age. Engelmann spruce (*Picea engelmannii*) and *Abies lasiocarpa* are present mostly in the sapling/seedling layer, though scattered mature and old-growth *Picea engelmannii* are typically present as well. This association is at the dry extreme of *Abies lasiocarpa* distribution and this species probably will never achieve canopy dominance. The canopy dominant over most of the stand is *Pseudotsuga*, though limber pine (*Pinus flexilis*) is a major component in patches. Common juniper (*Juniperus communis*) dominates the undergrowth, its cover generally exceeding 10%. The graminoid element is especially depauperate with only traces of nodding bluegrass (*Poa reflexa*) and Ross sedge (*Carex rossii*). Showy aster (*Aster conspicuus*) is the forb with highest cover in the plot and it and lanceleaved

stonecrop (*Sedum lanceolatum*) were noted as the prevalent forbs throughout the drier woodland environments. [Plot NHMTECRN98SC0037]

Pinus flexilis / Pseudoroegneria spicata
Woodland [PINFLE / PSESPI]
limber pine / bluebunch wheatgrass woodland

This plant association was found on a very rocky, thin-soil, limestone ridge with a northwest- and west-facing aspect and stretched up and downslope approximately 120 vertical feet from the 8,160 ft. contour. The ground surface is more than 85% exposed gravel and rock with bare soil constituting another 5-10%. There is no soil profile development and of the upper 10-20 cm. more than 50% is rock (gravel size or larger); this site verges on being a scree slope.

In this old growth stand of stunted limber pine (*Pinus flexilis*) and Douglas fir (*Pseudotsuga menziesii*; maximum height of 300 plus yr. old trees 22-24 ft.) all the veteran trees have very battered crowns and boles emblazoned with numerous lightning scars, often having more bare bole and scar tissue than functioning bark. Tree canopy cover ranges between 30 and 50%, composed of only the above named species; there are scattered seedling and samplings but the mid-sized age classes are missing. Shrubs like mountain snowberry (*Symphoricarpos oreophilus*) and common juniper (*Juniperus communis*) occur in only trace amounts. The herbaceous layer is very sparse (total cover <10 - 12%) and dominance shifts across the stand, some portions (or patches) being dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) others by grayish cymopteris (*Cymopterus glaucus*), lanceleaved stonecrop (*Sedum lanceolatus*), weedy milkvetch (*Astragalus miser*) and even many-flowered phlox (*Phlox multiflora*). Overall *Pseureogneria spicata* appears to consistently have the highest coverage, though this is generally less than 5%.

This is among the oldest PINFLE / PSESPI stands that have been inventoried in southwestern Montana; it is so old and lightning struck that none of the trees cored yielded a core that was countable beyond several hundred years, extrapolation yields ages in excess of 500 years. Stand structure is rather typical of xeric-site, old-growth with very scattered reproduction and few intermediate-aged trees. This stand represents the moisture stressed extreme of a type that is known as one of the driest of the woodland vegetation types in Montana with exception of *Juniperus* spp.-dominated woodlands. [Plot NHMTECRN98SC0036]

Pseudoroegneria spicata – Poa secunda Herbaceous Vegetation
[PSESPI – POASEC]
bluebunch wheatgrass – Sandberg's bluegrass grassland

This association is found as small patches on the very driest of spur-ridges that project to the north from the main east-west trending ridgeline of the Centennials. The combination of thin, rocky, limestone-derived soils, the western exposures of the spur-ridges (having the highest solar insolation values in a landscape with primarily northern exposures) and the prevailing southwesterly winds which scour snow from the windward slopes (west) and crests causes these ridges to be the most moisture-limited of any features in this landscape. Wind deflation causes more than 80% exposed limestone gravels; the depressed interstices are occupied by soil. Litter and basal area together comprise less than 5% of the surface area.

These ridges are so dry as to be incapbale of supporting much biomass, the total cover approaches the 10 % cutoff of sparsely vegetated communities. Though we have classed the plot as belonging to the bluebunch wheatgrass – Sandberg's bluegrass association (*Pseudoroegneria spicata – Poa secunda* Herbaceous Vegetation), its position and composition, both in alpha diversity and in the number of cushion plant species prominent, place it closer to the *P. spicata* / "Cushion Plant" community described by Cooper et al. (1995) for southwestern Montana (not yet recognized in TNC's Western Region Classification). The shrub component is almost nonexistent; Woods rose (*Rosa woodsii*) and green rabbitbrush (*Chrysothamnums viscidiflorus*) are so thinly scattered and depauperate as to be obscured by the herbaceous layer. Only two graminoids were present in the plot; the dominant *P. spicata* and a trace of Idaho fescue (*Fetuca idahoensis*) which is virtually ubiquitous in moutain grasslands of southwestern Montana. Low-growing, cushion-like plants or those more typically found in exposed subalpine to alpine environments (e.g. grayish cymopterus [*Cymopterus glaucus*], lance-leaved stonecrop (*Sedum lanceolatum*), Rocky Mountain douglasia (*Douglasia montana*), Cut-leaved daisy (*Erigeron compositus*), Parry's townsendia (*Townsendia parryi*) and sheep cinquefoil (*Potentilla ovina*) are conspicuously reperesented, though individually not exceeding 5% cover.

OVERALL BIODIVERSITY SIGNIFICANCE:
The Sheep Mountain RNA as currently defined is a small, intact sample of predominantly old-growth forest in the Rocky Mountains biome. It is in the middle of a

much larger and more diverse ecosystem, the whole north face of the Centennial Range, where the escarpment begins in shrubland/grassland at approximately 6,700 ft. and sweeping upward uninterrupted to the highest alpine sites at 9,600 feet. The RNA is encompassed by the Red Rocks Lakes Wilderness, affording additional protection to it and a much larger area. However, neither the RNA nor the surrounding wilderness area that is centered in the valleybottom capture the scale of the processes that operate in this landscape or more than a fraction of the habitat diversity existing in it.

Avalanches constitute one of the more salient of these processes; very steep terrain at the highest elevations causes avalanche chutes that fringe parts or all of two RNA borders. These chutes represent a feature of geological process as well as natural succession, and only two plots were taken in the array of wet-to-dry habitats in these avalanche features.

The RNA directly adjoins the only known extant occurrence of Whipple's Beardtongue (*Penstemon whippleanus*) in Montana, a species that was documented incidental to the baseline sensitive species work in the Centennial Valley for the Bureau of Land Management (Culver 1993). The avalanche chutes and talus slopes are also potential habitat for dwarf goldenweed (*Haplopappus nanus*), known only in Montana from a historical collection on the slopes south of Red Rock Lakes. There was not adequate time for completing a systematic survey of these two species across the RNA.

It was suggested in the original establishment record that the unique, exposed climatic conditions found within this RNA affords an excellent opportunity for studies in forest ecology and plant physiology. The same records ascribed wildlife values to this RNA, but they were not evaluated in this study.

LAND USE:
The site is essentially pristine; no timber cutting or evidence of domestic stock use was found. It receives limited recreational use from hunters and hikers.

MANAGEMENT COMMENTS:
This site would ideally be core of a much larger RNA spanning the full range of environments and processes of the Centennial Mountains. It lies within Red Rock Lakes Wilderness Area, which spans the lower segment of the 3,000 ft Sheep Mountain slope. The RNA could be expanded lengthwise within wilderness area boundaries, but any expansion of the vertical gradient ostensibly spans several jurisdictions (Red Rock Lakes National Wildlife Refuge, BLM Centennial Mountains Wilderness Study Area, USFS Targhee National Forest, Agricultural Research Service's Sheep Experiment Station).

DISCUSSION

The 15 RNAs and two additional study sites encompass a highly significant array of natural landscapes for Montana and the upper Missouri River watershed. Over 50 different plant associations are present, representing about 10% of all the recognized terrestrial plant association types in Montana. About a third of these examples are truly noteworthy in their quality and condition to be considered good or outstanding representatives of the biodiversity embodied in Montana's natural vegetation (represented by shaded cells in Table 3, pg 11)

These noteworthy plant associations are interpreted as representing significant biome features, the first of the RNA criteria in the Refuge Manual. RNAs may also represent stability in ecological communities, succession in ecological communities, habitat for threatened, endangered or sensitive species, and geological processes. Twelve RNA sites met one or more of these RNA establishment criteria in our partial assessment, as highlighted in Table 4 (below). We refer to this as a partial assessment because it did not address wildlife features.

Most of the five RNAs that do not contain exemplary ecological or botanical features were originally nominated based on wildlife values, and this study simply provides background habitat description.

Table 4. Partial matrix of National Wildlife Refuge RNA criteria and sites in Montana

SITE	BIOME	CLIMAX	SUCCESSION	TES PLANT SPECIES	GEO. PROCESS
Mullan Trail RNA	Yes				
Fourth Ridge RNA	Yes				
Hell Creek area	Yes		Yes		
Limber Pine RNA	Yes				
Manning Corral Prairie Dog Town RNA			Yes		
Missouri River Bottomlands RNA	Yes		Yes		Yes
Spring Creek RNA	Yes				
Two Calf – Douglas-fir RNA	Yes				Yes
York Island	Yes				
Sheep Mountain RNA	Yes	Yes	Yes		Yes
Medicine Lake sandhills area	Yes		Yes	Yes	Yes
Tepee Hills RNA	Yes				

Among the significant examples of plant associations, as determined by their outstanding quality and condition, several are considered potentially rare or vulnerable across their entire distribution. The Douglas fir / littleseed ricegrass forest (Pseudotsuga menziesii/Oryzopsis micrantha p.a.) is a well-developed plant association found only in central Montana that is rare on account of its geographical restriction, even if it is not under widespread threat. Three other plant associations may possibly be globally rare and are in varying stages of status evaluation in cooperation with adjoining states and provinces. They include: Rocky Mountain juniper/ Wyoming big sagebrush woodland (Juniperus scoulorum / Artemisia tridentata ssp. wyomingensis Woodland), Indian ricegrass / lemon scurf-pea sparse vegetation (Oryzopsis hymenoides / Psoralea lanceolata p.a) as found in sand dunes, and the porcupine needlegrass - thickspike wheatgrass grassland (Stipa curtiseta / Elymus lanceolatus Herbaceous Vegetation). We believe that most or all of the other high global ranks (G1-G3) for plant associations on Table 2 are artifacts of gaps in research or literature review.

There was relatively little overlap between plant association features at different sites. This may reflect the system of selecting sites or the inherent diversity within the NWR system. Even in cases of overlap, the "redundant" plant association features differed in their ecological context. For example, two significant stands of Artemisia tridentata ssp. wyomingensis / Pascopyrum smithii were identified: on York Island, and on Fourth Ridge just to the west. Yet they differed in that the York Island shrubland is pervasive across the uplands and represents a typical landscape, while the Fourth Ridge shrubland is part of a juniper woodland mosaic in an extreme example in an unusually harsh setting. Two sites of Pascopyrum smithii -Nasella viridula p.a were documented at Mullan Trail RNA and in the Hell Creek area, the former in a glaciolacustrine setting and the latter in an unglaciated setting where the community is a post-fire seral stage. Many sites had vestiges or patches of Stipa comata – Bouteloua gracilis – Carex filifolia, but only Spring Creek had more than 10 acres in good condition and surrounded by more-or-less intact upland landscape approaching good representation of the grassland system and processes. Even the two RNAs established to represent prairie dogs towns were studies in contrast: an exotic species had taken over in Prairie Dog Island RNA whereas native species associated with early seral conditions prevail across the prairie dog town site of Manning Corral Prairie Dog Town RNA.

Other recurrent patterns appear in collectively considering these 12 sites. They include some of the few protected public lands in eastern Montana with intact mesic, productive plant associations. Such inventory features include the once-widespread Pascopyrum smithii-Nasella viridula p.a. of Mullan Trail RNA as mentioned above. The other associations of high biomass are highly localized features like the Stipa curtiseta – Elymus lanceolatus p.a. of Tepee Hills RNA, restricted to north-facing slopes.

The largest RNA, the Missouri River Bottomlands RNA, is in a class by itself, encompassing riverine processes and succession, and containing relatively large Missouri River islands, relatively large stands of plains cottonwood, and erodible valley slopes. The presence of intact landscape processes, as well as the plant association compohents, are enhanced by representation of active geological processes, which enhance system sustainability. Geological processes are also captured in the sandhills segment of the Medicine Lake Wilderness Area, the largest sandhills in Montana with its aeolian processes and succession. The Medicine Lake sandhills also have the highest numbers of Montana plant species of special concern among study sites because of the uncommon sand dune habitat. The third notable RNA example of geological process are the avalanche chutes of the Sheep Mountain RNA, although the RNA includes only small portions of two chutes.

CONCLUSIONS AND RECOMMENDATIONS

In addition to background and habitat information for each site, this report provides a baseline for assessing the diversity of ecological features and processes represented in Montana's U.S. Fish and Wildlife Service RNAs. Together with information on U.S. Forest Service RNAs and BLM "Areas of Critical Environmental Concern" (ACECs), this assessment can be used to help systematically identify protected or unprotected habitats and landscapes in Montana and the region.

While boundary review per se was not the focus of this project, information we collected suggests some possible changes that would better fulfill establishment or representation objectives for two of the RNAs studied. These comments focus on a landscape perspective, including gradients and processes, which are important to the long-term viability of communities and species within the sites. Some of the RNAs already encompass broad gradients. The Spring Creek RNA encompasses a well-developed ravine system with its full complement of habitats. The Limber Pine RNA encompasses a typical Missouri Breaks cross-section with a complementary suite of plant associations. The Missouri River Bottomland in combination with the Two Calf-Douglas-fir RNA similarly encompasses a cross-section of Missouri Breaks landscape, though the difference between the vegetation on the former with its sandstone and siltstone bedrock is a striking contrast with the vegetation of the latter on Bearpaw Shale and bentonite.

The value of the Missouri River Bottomlands RNA (representing the valley slope gradient) is enhanced by the adjacent Two Calf-Douglas-fir RNA. However, the boundary may be inadequate to effectively represent the latter forest type and accompanying upland processes, and boundary review for the latter is recommended.

The Sheep Mountain RNA area is not large enough to represent viable stands and landscape processes, but is surrounded by designated wilderness on the Refuge. The Refuge extends to midslope positions in the Centennial Range so any recognition of intact landscape gradients would involve collaboration with other agencies. Sheep Mountain is also in a geographic class by itself among Fish & Wildlife Service RNAs as a Rocky Mountain site rather than a Great Plains site, with intact old-growth plant associations that are otherwise incompletely represented in the Forest Service RNA system in Montana. We recommend that the Service consider expanding the RNA lengthwise on Refuge lands and explore elevational expansion of the RNA to encompass the unbroken ecological gradient that extends into higher elevations onto BLM and USFS lands.

Though a "gap analysis" and exploration of alternative or additional sites was beyond the scope of this project, some observations emerged from our studies. Most important is that despite the array of plant associations within this USFWS RNA system, it does not include large areas of once-extensive plant associations that covered the Great Plains. However, some RNAs we studied occur within larger areas where these important systems are represented in good condition. The Charles M. Russell NWR offers outstanding and unique opportunities to identify and sustain large, intact plains landscape features not found elsewhere on public lands in Montana. Further field assessment is recommended beyond the RNA boundaries to document the locations and condition of key communities and landscape complexes to provide information that can assist with management and conservation of key ecological features and areas on the Refuge.

On as smaller scale, the Manning Corral Prairie Dog Town site could include representative south-facing breaklands habitat in addition to prairie dog town succession. We also noted that few, well-developed plant associations or wetland settings with intact hydrological gradients were found, and these represent a gap in types represented within existing RNAs.

In conclusion, we recommend a "next phase" of effort focussed on identifying areas that would fill

gaps and achieve representation at scales more consistent with ecological processes and the historic nature of once-widespread types. Much of this effort should be focussed on the Charles M. Russell NWR and surrounding public lands, where there may be outstanding representation of large scale landscape systems and conservation opportunities potentially unique in Montana and the region. Future work should also include assessment of wildlife representation and values, emphasizing rare, declining and keystone species.

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Appendix A

Community Survey Form

COMMUNITY SURVEY FORM (MTNHP) GENERAL PLOT DATA:

A. IDENTIFICATION AND LOCATION:

MANUAL: ________ UNITS: __ft. __m

PLOT NO. _ : MON. _ _ DAY: _ _ YEAR: _ _ _ _ EOCODE:________________

EXAMINER(S): ____

POTENTIAL. NAT. COMM.: ________________________ C.T.: ________________________

BAILEY CLASS.: SECTION ______________ SUBSECTION ______________ LTA ______________

POLYGON NO.: _ _ _ POLYGON NAME: ________________________

SITE NAME: ________________________________ STATE: ______ COUNTY: ______________

USGS QUAD NAME: ________________________________ QUAD CODE: _ _ _ _ _ _ _ _ _ _

EXTENT C.T./P.A W/IN LANDSCAPE: Matrix, Lg. Patch, Sm. Patch (circle) COMMUNITY. SIZE (acres): ____________

GPS REF. NO.:______________ **Field UTM X** __ __ __ __ __ __ __ mE **Field UTM Y** __ __ __ __ __ __ __ __ mN

Corrected UTM X __ __ __ __ __ __ __ mE **Corrected Field UTM Y** __ __ __ __ __ __ __ __ mN **UTM Zone** _______

Public Land Survey:T, *N or S* ___ ___; **R,** *E or W* ___ ___; **Sec.** ___ ___; **1/4S** ____; **4/4**____; **4/4/4**____; **4/4/4/4** ____:

LATITUDE: _ _ _(deg.); _ _(min.); _ _ . _ _(sec.): LONGITUDE: _ _ _(deg.); _ _(min.); _ _ . _ _(sec.);

OWNERSHIP (circle): Private (Name:______________________), U. S. Forest Service, BLM, Tribal, Bur. of Rec. , State MT, ______________

PLOT TYPES: __ __ __ __ __ PLOT SIZE: ________ RADIUS/LN; ________WIDTH SURVEY: __ __ __ __ __ __ __

PHOTOGRAPHY: (type, azimuth, etc.) ____

DIRECTIONS (to plot):____

____

____

____

ENVIRONMENTAL FEATURES:

DL: ______________ SOIL RPT: ________________________________

SOIL UNIT: ________________________ SOIL TAXON: ________________________

SOIL TEXTURE:(circle one) clay; sandy clay; silty clay; clay loam; silty clay loam; sandy clay loam; loam; silt loam; silt; sandy loam; loamy sand; sand; x= unable to assess

PARENT MATERIAL(S):________________________________ LANDFORM: ______________

PLOT POSITION: ____________________ SLOPE SHAPE: (vert.)____ ; (hor.)____ ASPECT(°): _ _ _ SLOPE (%): _ _ _

ELEVATION: (ft. or M)_ _ _ _ _ EROSION POT.: __________ EROS. TYPE(S): ____ ____

HORIZON ANGLE: N _____; E _____; S _____; W _____ IFSLP: ____________ IFVAL: ____________

SPECIAL FEATURE(S): ____

GROUND COVER (by cover classes): ___ SOIL+___ GRAVEL+___ ROCK + ___ LITTER + ___WOOD + ___ MOSS + ___ BASAL VEG. + ___ OTHER =100%

(bare soil = <2mm fraction; gravel = 2mm to <10cm; rock [inc. cobbles, boulders] = > 10cm, wood = > 1cm; litter = organic < 1 cm; other = water, lichen, specify

DISTURBANCE HISTORY (**include estimation of weed populations here**; type, intensity, frequency, season):

____

____

____

RIPARIAN/WETLAND FEATURES:

COWARDIN CLASS.: SYST. Palustrine, Lacustrine, Riverine (circle) SUBSYST. ____________________ CLASS.________________

SUBCLASS.______________ DOMINANCE TYPE ________________________________

HGM CLASS.: ____

VALLEY FLOOR GRADIENT: ________ FLOODPLAIN WIDTH: (m, ft.) __________ BED MATERIAL: ______________

CHANNEL WIDTH: __________ CHANNEL DEPTH: ________ CHANNEL ENTRENCH.: ________

SURFACE (STANDING) WATER DEPTH: ________ (cm or in., observed): ______ MEAN ______ MAXIMUM

DIST. FROM WATER: ________________ AVE. ANN. HIGH WATER: ________ (OBSERVED OR ESTIMATE, CIRCLE)

PONDING EVIDENCE: ________ (A aerial photo, B banded veg C rocks w/ w/o carbonate coat, D sediment deposition, L rocks w/ and w/o lichen, R herb wrack lines, S water/silt stains)

DURATION of INUNDATION: ______ (days, this year)

INUNDATION PERIOD/HYDRO. REGIME: (circle one) Permanently Flooded, Saturated, Semipermanently Flooded, Seasonally Flooded, Temporarily Fld , Intermittently Fld

SEDIMENT DEPOSITION: ______COVER (%), _______ DEPTH (cm or in.)

BANK STABILITY: Rills, Gully Cutting, Headcuts, Slumps, Undercut Bank:

CAPILLARY FRINGE: _______DEPTH TO CAP. FRINGE; _______THICKNESS CAP. FRINGE; _______DEPTH to SATURATION (free water)

ORGANIC HORIZON THICKNESS (cm or in.): ______ MEAN ______ MIN. ______ MAX.; _____Oa _____Oe _____Oi

OCULAR PLANT SPECIES DATA:

PLOT NUMBER: _____ NO. SPECIES: ___ PNC: _____
MINIMUM COVER VALUE:___

TREES: TOTAL CV. _____ MEAN HT. _____
TALL CV. _____ MED. CV. _____
LOW CV. _____ GRND.CV. _____

Tree Height|Canopy Cover by Dia. Class

SPECIES IDENT.*	>18″	<18″	<9″	<5″	1″
T 1 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 2 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 3 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 4 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 5 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 6 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 7 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]
T 8 _ _ _ _ _ _	[___/___	___/___	___/___	___/___	___/___]

SHRUBS: TOTAL CV. _____ MEAN HT. _____
TALL CV. _____ MED CV. _____
LOW CV. _____ GRND.CV. _____

S 1 _ _ _ _____ _ _ _ _____	/___	[___]
S 2 _ _ _ _____ _ _ _ _____	/___	[___]
S 3 _ _ _ _____ _ _ _ _____	/___	[___]
S 4 _ _ _ _____ _ _ _ _____	/___	[___]
S 5 _ _ _ _____ _ _ _ _____	/___	[___]
S 6 _ _ _ _____ _ _ _ _____	/___	[___]
S 7 _ _ _ _____ _ _ _ _____	/___	[___]
S 8 _ _ _ _____ _ _ _ _____	/___	[___]
S 9 _ _ _ _____ _ _ _ _____	/___	[___]
S10 _ _ _ _____ _ _ _ _____	/___	[___]
S11 _ _ _ _____ _ _ _ _____	/___	[___]
S12 _ _ _ _____ _ _ _ _____	/___	[___]

GRAMINOIDS: TOT. CV. _____ MEAN HT. _____
MED. CV. _____ LOW CV. _____
GRND. CV. _____

G 1 _ _ _ _____ _ _ _ _____	/___	[___]
G 2 _ _ _ _____ _ _ _ _____	/___	[___]
G 3 _ _ _ _____ _ _ _ _____	/___	[___]
G 4 _ _ _ _____ _ _ _ _____	/___	[___]
G 5 _ _ _ _____ _ _ _ _____	/___	[___]
G 6 _ _ _ _____ _ _ _ _____	/___	[___]
G 7 _ _ _ _____ _ _ _ _____	/___	[___]
G 8 _ _ _ _____ _ _ _ _____	/___	[___]
G 9 _ _ _ _____ _ _ _ _____	/___	[___]
G10 _ _ _ _____ _ _ _ _____	/___	[___]
G11 _ _ _ _____ _ _ _ _____	/___	[___]
G12 _ _ _ _____ _ _ _ _____	/___	[___]
G13 _ _ _ _____ _ _ _ _____	/___	[___]
G14 _ _ _ _____ _ _ _ _____	/___	[___]
G15 _ _ _ _____ _ _ _ _____	/___	[___]
G16 _ _ _ _____ _ _ _ _____	/___	[___]

FORBS: TOTAL CV. _____ MEAN HT. _____
MED. CV. _____ LOW CV. _____
GRND. CV. _____

SPECIES IDENTIFICATION	HT.	CCC
F 1 _ _ _ _____ _ _ _ _____	/___	[___]
F 2 _ _ _ _____ _ _ _ _____	/___	[___]
F 3 _ _ _ _____ _ _ _ _____	/___	[___]
F 4 _ _ _ _____ _ _ _ _____	/___	[___]
F 5 _ _ _ _____ _ _ _ _____	/___	[___]
F 6 _ _ _ _____ _ _ _ _____	/___	[___]
F 7 _ _ _ _____ _ _ _ _____	/___	[___]
F 8 _ _ _ _____ _ _ _ _____	/___	[___]
F 9 _ _ _ _____ _ _ _ _____	/___	[___]
F10 _ _ _ _____ _ _ _ _____	/___	[___]
F11 _ _ _ _____ _ _ _ _____	/___	[___]
F12 _ _ _ _____ _ _ _ _____	/___	[___]
F13 _ _ _ _____ _ _ _ _____	/___	[___]
F14 _ _ _ _____ _ _ _ _____	/___	[___]
F15 _ _ _ _____ _ _ _ _____	/___	[___]
F16 _ _ _ _____ _ _ _ _____	/___	[___]
F17 _ _ _ _____ _ _ _ _____	/___	[___]
F18 _ _ _ _____ _ _ _ _____	/___	[___]
F19 _ _ _ _____ _ _ _ _____	/___	[___]
F20 _ _ _ _____ _ _ _ _____	/___	[___]
F21 _ _ _ _____ _ _ _ _____	/___	[___]
F22 _ _ _ _____ _ _ _ _____	/___	[___]
F23 _ _ _ _____ _ _ _ _____	/___	[___]
F24 _ _ _ _____ _ _ _ _____	/___	[___]
F25 _ _ _ _____ _ _ _ _____	/___	[___]
F26 _ _ _ _____ _ _ _ _____	/___	[___]
F27 _ _ _ _____ _ _ _ _____	/___	[___]
F28 _ _ _ _____ _ _ _ _____	/___	[___]
F29 _ _ _ _____ _ _ _ _____	/___	[___]
F30 _ _ _ _____ _ _ _ _____	/___	[___]
F31 _ _ _ _____ _ _ _ _____	/___	[___]
F32 _ _ _ _____ _ _ _ _____	/___	[___]
F33 _ _ _ _____ _ _ _ _____	/___	[___]
F34 _ _ _ _____ _ _ _ _____	/___	[___]
F35 _ _ _ _____ _ _ _ _____	/___	[___]
F36 _ _ _ _____ _ _ _ _____	/___	[___]

FERNS AND ALLIED FORMS (E.G *EQUISETUM, LYCOPODIUM*):
TOTAL CV.____ MEAN HT. _____ MED. CV._____
LOW CV. ____ GRND CV. _____

F 1 _ _ _ _____ _ _ _ _____	/___	[___]
F 2 _ _ _ _____ _ _ _ _____	/___	[___]
F 3 _ _ _ _____ _ _ _ _____	/___	[___]
F 4 _ _ _ _____ _ _ _ _____	/___	[___]
F 5 _ _ _ _____ _ _ _ _____	/___	[___]

BRYOIDS & LICHENS: TOTAL CV. Broids: ____ TOTAL CV. Lichens: _____

B 1 _____	/ __	[___]	L 1 _____	/ __	[___]
B 2 _____	/ __	[___]	L 2 _____	/ __	[___]
B 3 _____	/ __	[___]	L 3 _____	/ __	[___]
B 4 _____	/ __	[___]	L 4 _____	/ __	[___]
B 5 _____	/ __	[___]	L 5 _____	/ __	[___]
B 6 _____	/ __	[___]	L 6 _____	/ __	[___]
B 7 _____	/ __	[___]	L 7 _____	/ __	[___]
B 8 _____	/ __	[___]	L 8 _____	/ __	[___]

* **Tree canopy cover for mature (> 5 in. dbh) and seedlings/saplings (< 5 in. dbh.) is the minimum breakdown for tree stratum, for any species;**
[1] **Canopy Cover Classes (Percent Values):** 0; T = >0, <1; P = ≥1, <5; 1 = ≥5,<15; 2 = ≥15, <25; 3 = ≥25, <35; 4 = ≥35, <45; 5 = ≥45, <55; 6 = ≥55, <65; 7 = ≥65, <75; 8 = ≥75, <85; 9 = ≥85, <95; F = ≥95
[2] **First three letters of genus and species; write complete species name if confusion possible within lifeform: use © to indicate collected taxon**

Appendix B

Plant Species of Special Concern Survey Form

Plant Species of Special Concern Survey Form

MONTANA NATURAL HERITAGE PROGRAM
P.O. Box 201800, 1515 E. Sixth Avenue, Helena, MT 59620-1800

SCIENTIFIC NAME: _____ DATE OF SURVEY: ____/____/____

OBSERVER(S): _____

WORK LOCATION / ADDRESS: _____

Location: (attach a copy of pertinent 7.5' or 15' topographic map section with locations of populations/subpopulations outlined; one map for each sensitive species described.)

COUNTY: _____ USGS QUAD: _____

TOWNSHIP: _____ RANGE: _____ SEC.(s): _____ ¼ SEC.: _____

ADDITIONAL T/R/S, SECTIONS OR ¼ SEC.: _____

NATL. FOREST DISTRICT/BLM DISTRICT RA/OTHER: _____

DIRECTIONS TO SITE (Refer to towns, roads, trails, other geographic features): _____

_____

_____

_____

Species Autecology

TOTAL NUMBER OF INDIVIDUALS (estimated or exact population count; sum clumps or stems if vegetative):
_____

_____

NUMBER OF SUBPOPULATIONS AND SUBTOTALS (if applicable): _____

SIZE OF AREA COVERED BY POPULATION (acres): _____

PHENOLOGY (% flowering, fruiting, vegetative): _____

EVIDENCE OF DISEASE, PREDATION, INJURY: _____

EVIDENCE OF SEED DISPERSAL, ESTABLISHMENT: _____

POPULATION TREND/OTHER COMMENTS: _____

Habitat: (Describe the distinguishing features of the environment on next page, adding landform and the nature of the species' habitat in the setting):

_____

_____

_____

_____

_____

ELEVATION (mean or range): _____ ASPECT: ☐N ☐NE ☐E ☐SE ☐S ☐SW ☐W ☐NW

% SLOPE: _____ SLOPE SHAPE ☐ Concave ☐ Convex ☐ Straight ☐ Other _____

TOPOGRAPHY: ☐ Crest ☐ Upper ☐ Mid ☐ Lower ☐ Bottom ☐Other _____

MOISTURE: ☐ Dry ☐ Moist ☐ Saturated ☐Inundated ☐ Seasonal seepage ☐ Other_____

LIGHT EXPOSURE: ☐ Open ☐ Shaded ☐ Partial shade ☐ Other _____

PARENT MATERIAL: _____

SURFACE COVER (TOTAL %): MOSS/LICHEN _____ BASAL VEG._____ BARE GROUND _____

SOIL TEXTURE/SERIES: _____

CANOPY COVER: TREE (%) _____ SHRUB (%) _____ FORB (%) _____ GRAMINOID(%)_____

PLANT COMMUNITY: (dominant species at present, age and structure notes):_____

_____

CLIMAX VEGETATION (if not above): _____

ADDITIONAL ASSOCIATED PLANTS (include most common, conspicuous, and characteristic spp.):_____

_____

_____

_____

_____

EVIDENCE OF DISTURBANCE: _____

Documentation:

PHOTOGRAPH TAKEN? (if so, indicate photographer and depository): _____

SPECIMEN TAKEN? (if so, list collector, collection #, and repository): _____

_____

IDENTIFICATION (name of person making determination, and/or flora used):_____

_____

ECODATA PLOT NUMBER (attach photocopied data sheets): _____

OTHER DOCUMENTATION OR REFERENCES: _____

Comments:

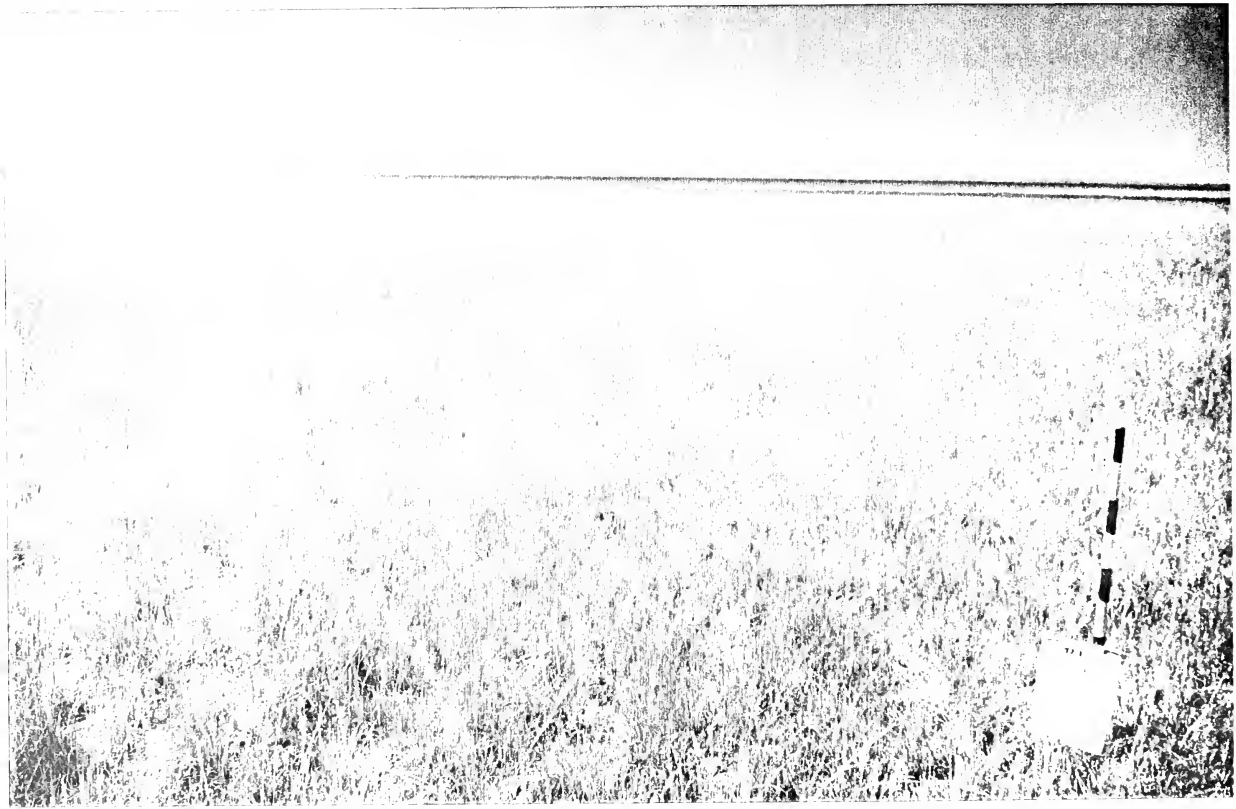
_____

_____

_____

Appendix C

Photographs of State-significant Vegetation Features

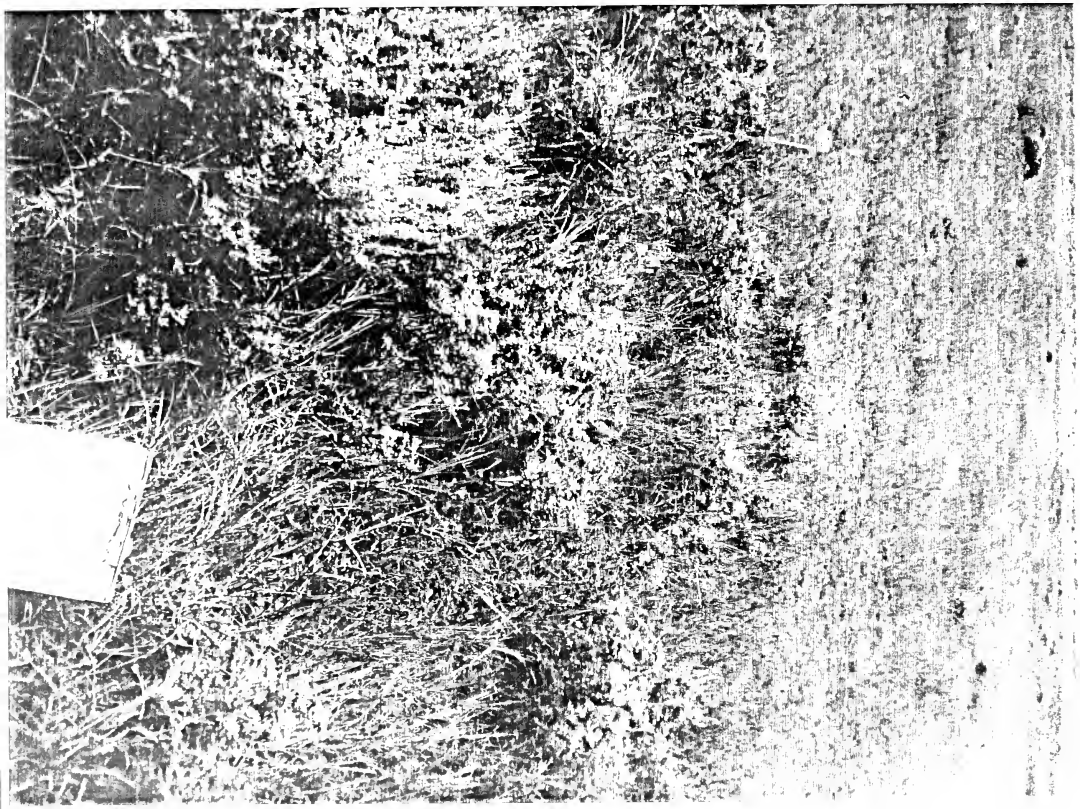


Glaciated example of the once-widespread western wheatgrass – green needlegrass prairie (*Pascopyrum smithii – Nasella viridula* Herbaceous Vegetation) at Mullan Trail RNA – Benton Lake NWR

Good example and unusual mosaic pattern formed by Rocky Mountain juniper woodland (*Juniperus scopulorum/ Artemisia tridentata* ssp. *wyomingensis* Woodland) at Fourth Ridge RNA – Charles M. Russell NWR

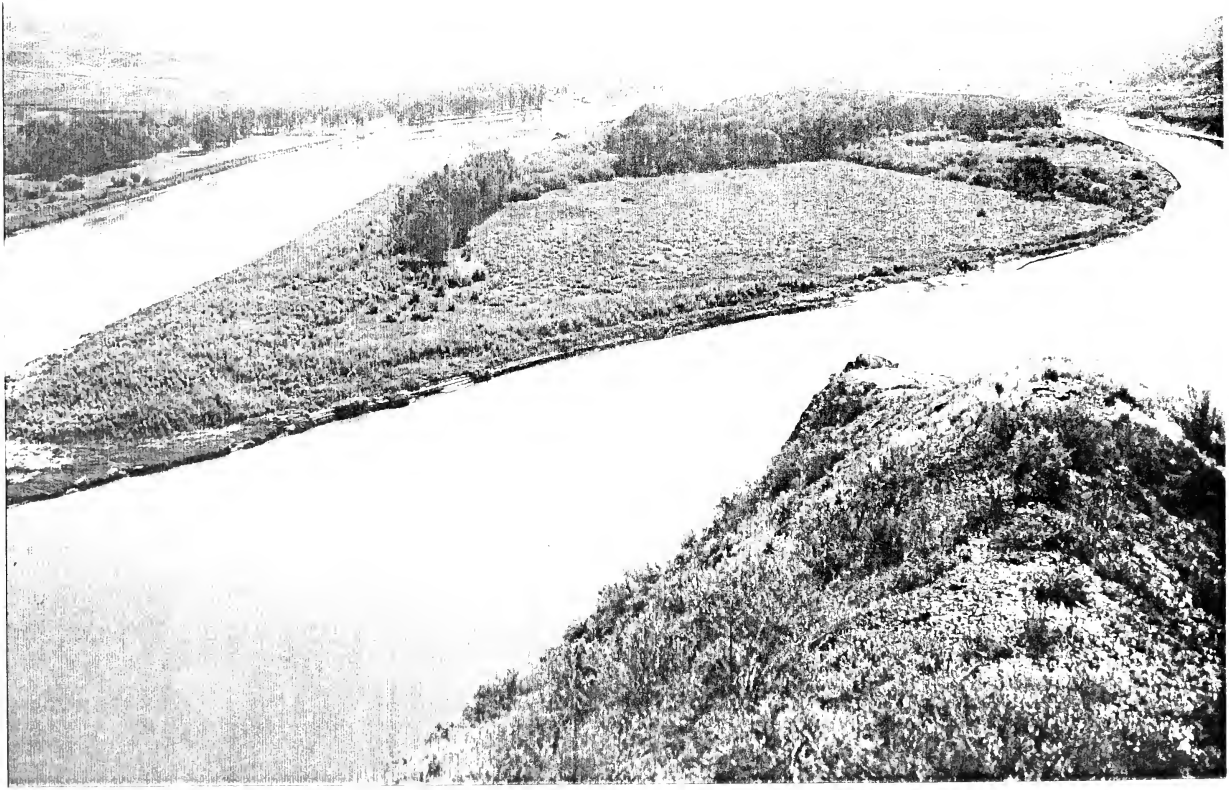
Unglaciated example of the once-widespread western wheatgrass – green needlegrass prairie (*Pascopyrum smithii – Nasella viridula* Herbaceous Vegetation) at Hell Creek potential RNA – Charles M. Russell NWR

Good representation of Missouri Breaks gradient at Limber Pine RNA – Charles M. Russell NWR; foreground includes prairie sandreed – sun sedge prairie (*Calamovilfa longifolia – Carex inops* Herbaceous Vegetation) and in the background *Juniperus scopulorum* and *Pinus ponderosa* dominate northern exposures and ravines



Prairie dog succession within sagebrush shrubland at Manning Corral Prairie Dog Town RNA – Charles M Russell NWR, foreground is Wyoming big sagebrush/ western wheatgrass steppe (*Artemisia tridentata* ssp *wyomingensis*/ *Pascopyrum smithii* Shrubland) and background vegetation was changed by prairie dogs

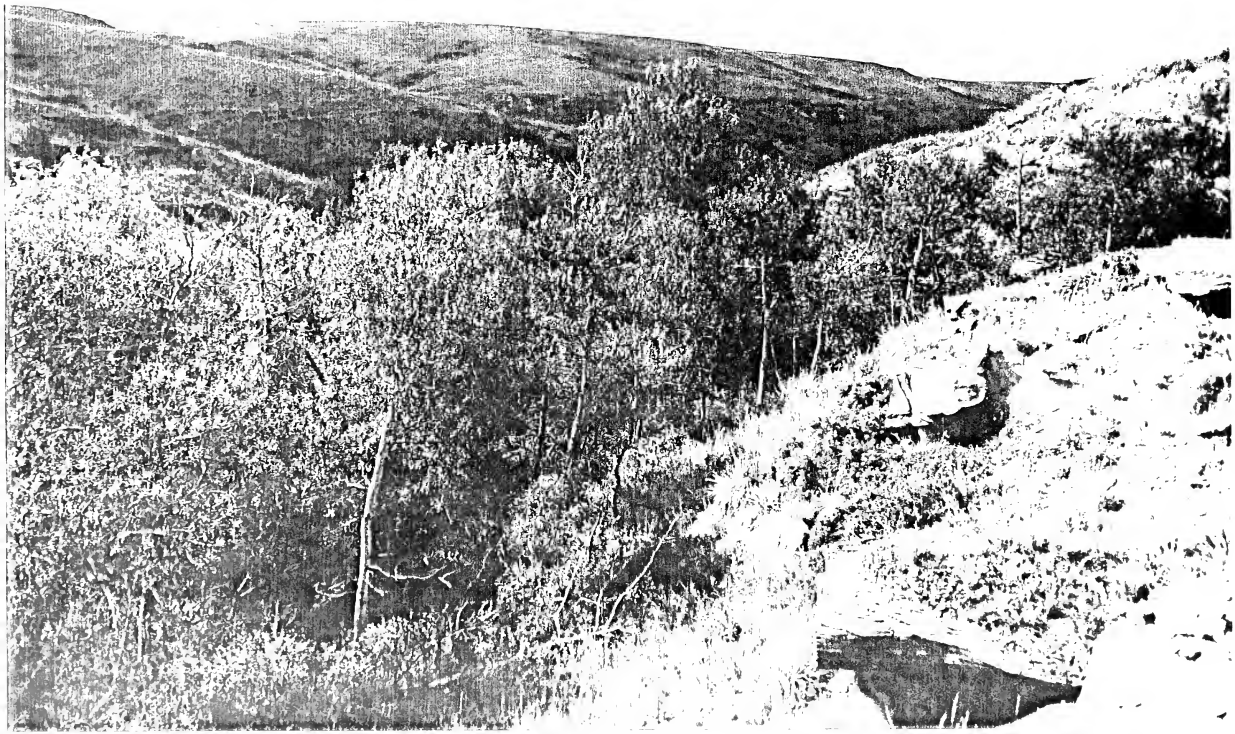
Natural succession with blue grama prairie (*Bouteloua gracilis* Herbaceous Vegetation) as dominant across former prairie dog town at Manning Corral Prairie Dog Town RNA – Charles M. Russell NWR, light-colored grass present in extensive patches is the native tumblegrass (*Schedonnardus paniculatus*)



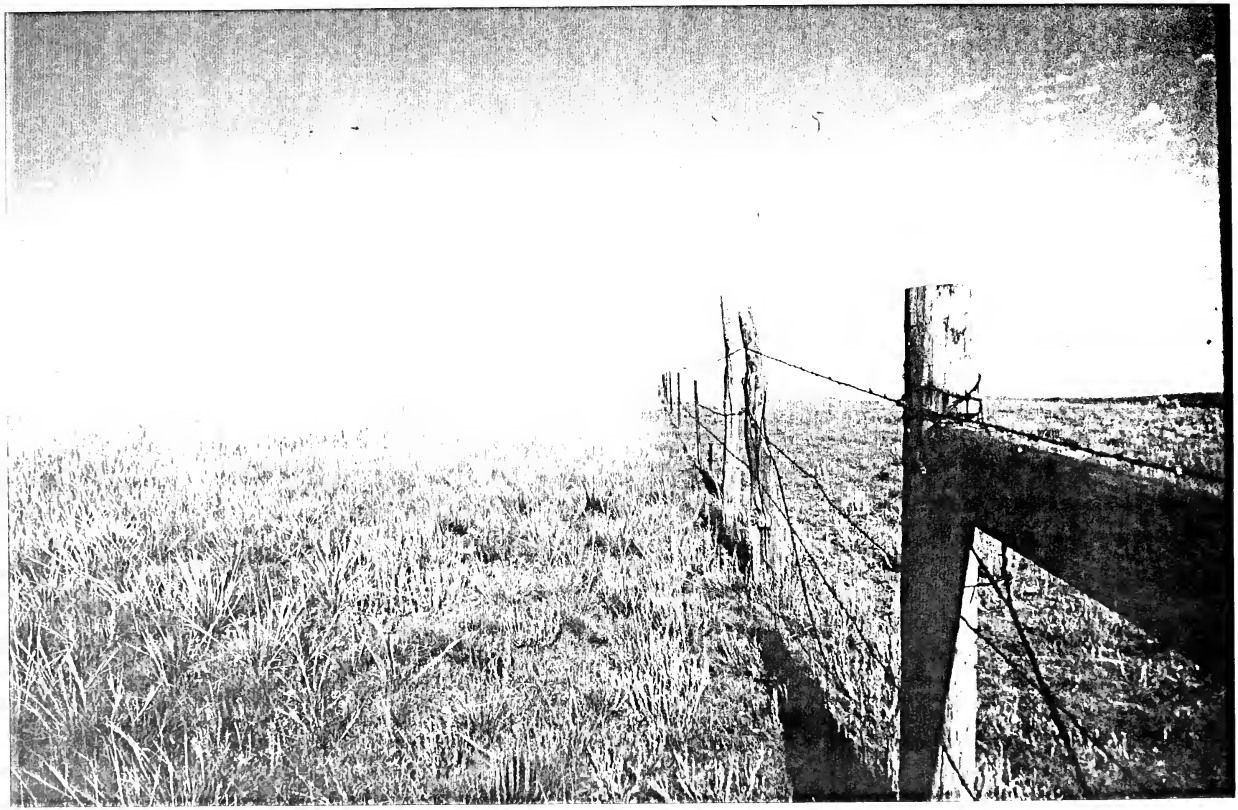
Good example of intact island communities on Two Calf Island in Missouri River Bottomlands RNA – Charles M. Russell NWR, including silver sagebrush shrubland (*Artemisia cana/ Pascopyrum smithii* Herbaceous Vegetation), plains cottonwood woodland (*Populus deltoides/ Symphoricarpos occidentalis* woodlands) and willow (*Salix* spp.) thickets

Intact stand of plains cottonwood/ western snowberry woodland (*Populus deltoides/ Symphoncarpos occidentalis* Woodland) at Hess Bottoms of Missouri River Bottomlands RNA – Charles M. Russell NWR, mature plains cottonwood mostly 16-20 inches in diameter

Representative black greasewood / western wheatgrass shrubland (*Sarcobatus vermiculatus / Pascopyrum smithii* Shrubland) at Missouri River Bottomlands RNA – Charles M Russell NWR; black greasewood is also a major component of the vegetation on steep valley slopes to the right

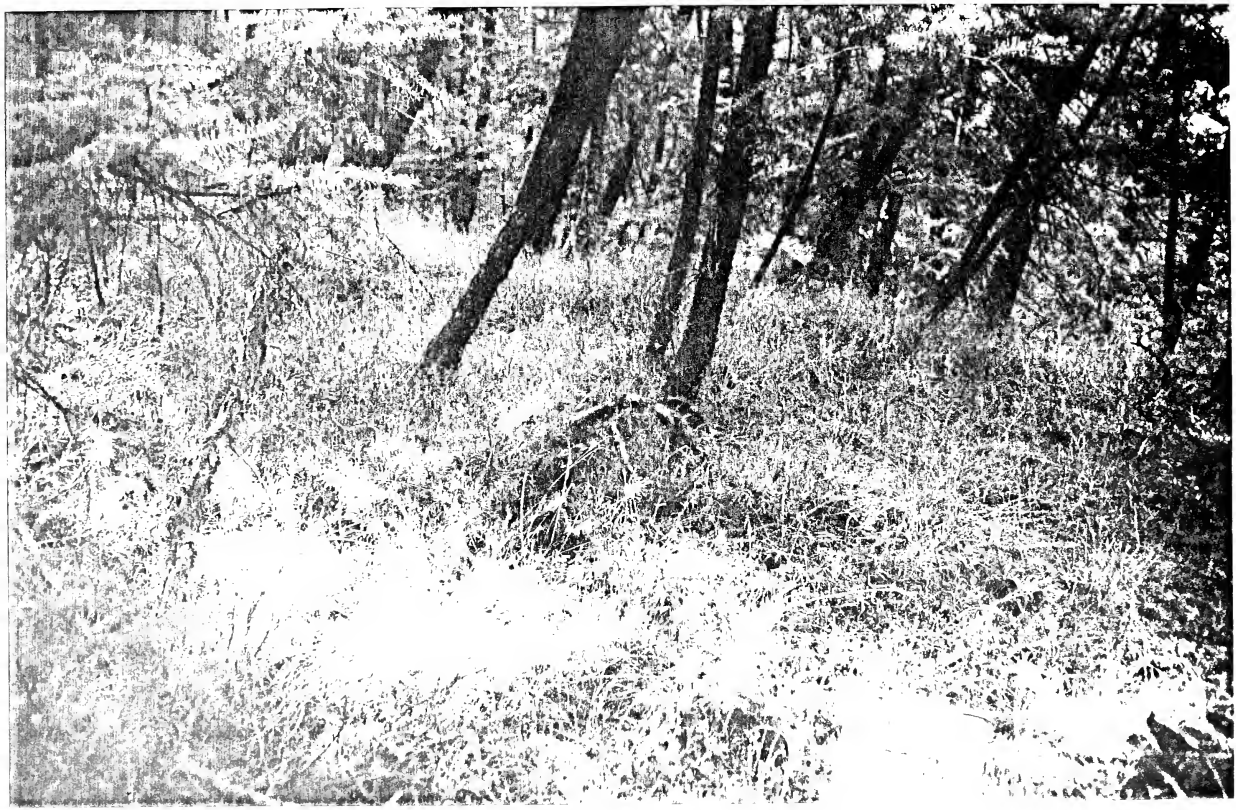


Head of ravine woodland with aspen bordering green ash/ chokecherry woodland (*Fraxinus pennsylvanica / Prunus virginiana* Woodland) at Spring Creek RNA – Charles M. Russell NWR; sandstone slopes to the right support a bunchgrass mosaic in which skunkbrush sumac (*Rhus aromatica*) and yucca (*Yucca glauca*) are consistent components

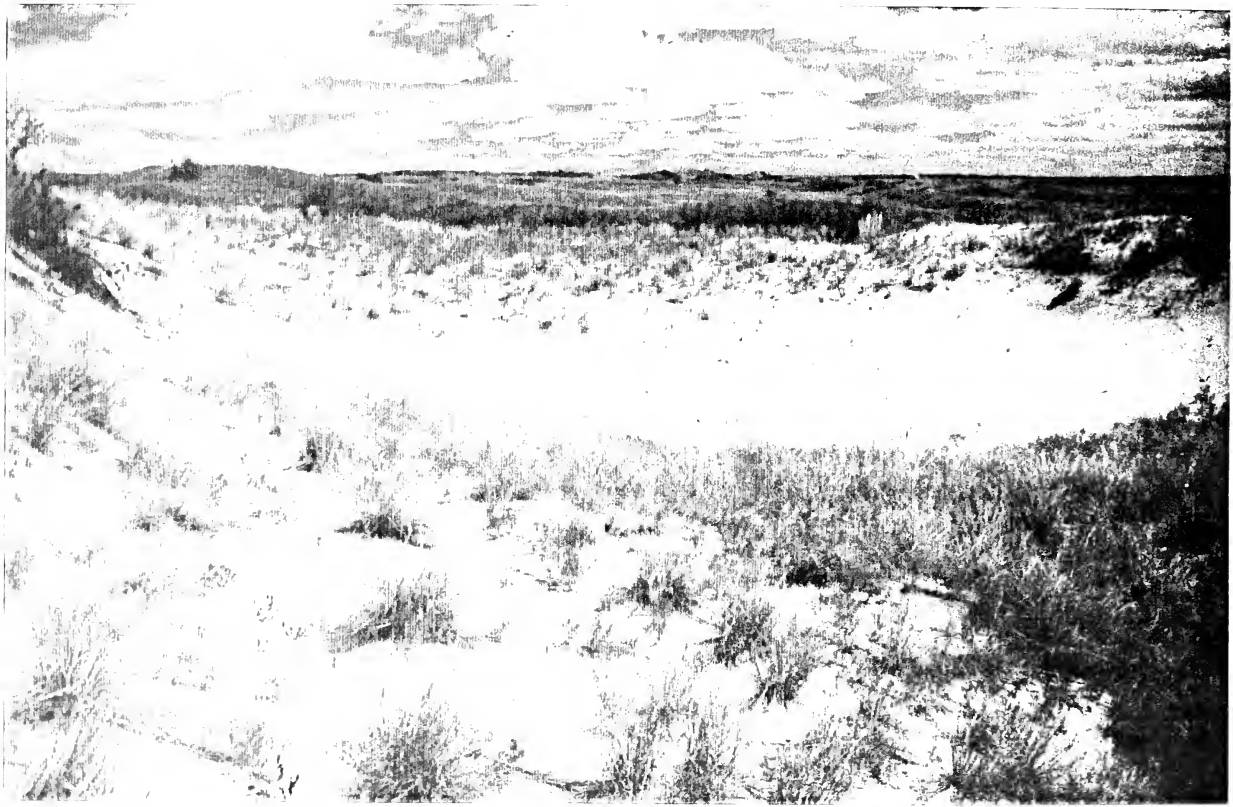


Fenceline contrast with excellent condition prairie (left) of needle-and-thread – blue grama (*Stipa comata – Bouteloua gracilis* Herbaceous Vegetation) at Spring Creek RNA – Charles M. Russell NWR, poor range condition landscape (right) is dominated by *B. gracilis* and fringed sage (*Artemisia frigida*)

Good example of the widespread Wyoming big sagebrush/ western wheatgrass shrubland (*Artemisia tridentata* ssp. *wyomingensis* / *Pascopyrum smithii* Shrubland) at York Island RNA – Charles M. Russell NWR; in the background just below horizon are seen patches of yellow sweetclover



Good example of the uncommon Douglas fir/ little-seed ricegrass forest (*Pseudotsuga menziesii/ Oryzopsis micrantha* Forest), at Two Calf – Douglas fir RNA – Charles M. Russell NWR. undergrowth is dominated by *O. micrantha* and bright green lichens



Good example of the indian ricegrass – slimleaf scurpea barrens (*Oryzopsis hymenoides – Psoralea lanceolata* Sparse Vegetation) seral community surrounding an active dune blowout area at Medicine Lake Sandshills – Medicine Lake NWR

Good example of uncommon porcupine grass – thick-spike wheatgrass prairie (*Stipa curtiseta – Elymus lanceolatus* Herbaceous Vegetation) at Tepee Hills RNA – Medicine Lake NWR; a diverse community type found on north-facing slopes

Old-growth limber pine/ bluebunch wheatgrass Woodland (*Pinus flexilis / Pseudoroegneria spicata* Woodland) at Sheep Mountain RNA – Red Rock Lakes NWR; numerous dead limbs and scars radiating from the crown downward testify to multiple lightning strikes on these veteran trees

Lower end of Sheep Mountain RNA – Red Rock Lakes NWR, with an open ridge of bluebunch wheatgrass -- Sandberg's bluegrass prairie (*Pseudoroegneria spicata – Poa secunda* Herbaceous Vegetation), these wind-impacted ridgeline balds constitute the driest environments within the RNA

Old-growth subalpine fir / common juniper woodland (*Abies lasiocarpa / Thalictrum occidentale* Woodland) with Douglas fir (*Pseudotsuga menziesii*) contributing the great majority of tree cover, at Sheep Mountain RNA – Red Rocks Lakes NWR; heavy browsing by moose prevents *A. lasiocarpa* from growing out of the seedling/sapling size class

Appendix D

Vegetation Constancy-cover sampling data

APPENDIX D.

Cover Synthesis and Constancy/Cover Matrices for selected community types sampled on US Fish and Wildlife Service Research Natural Areas (RNAs)

The index immediately below is used to associate particular plant associations/community types with ECODATA plot numbers and with their position in the Cover Synthesis (Stand) Table that follows (genus, species and six-character acronyms listed in species list of Appendix G); in the table that follows the above listed number refers to community designation (for example within Benton Lake NWR, Mullen Trail RNA has two number 1s referencing the PASSMI-NASVIR plant association and the subtending site numbers 1 and 2 indicate there are two plots representing this vegetation type). Presentation order of refuges and of RNAs within refuges is alphabetical; the order of community types follows their order of presentation in text, which is basically according to relative extent within a given refuge, the areally extensive listed first.

National Wildlife Refuge (NWR: Research Natural Areas; Plant Community Types & Site Numbers [16 character designation])

BENTON LAKE NWR

1. Mullan Trail RNA [MT: PASSMI-NASVIR]
   1. NHMTECMT97SC0001 2. NHMTECMT97SC0002

CHARLES M. RUSSELL NWR

2. Fourth Ridge RNA [FR: ARTTSW-PASSMI]
   3. NHMTECFR97SC0001 4. NHMTECFR97SC0003 5. NHMTECFR97SC0006

3. Fourth Ridge RNA [FR: JUNSCO/ARTTSW]
   6. NHMTECFR97SC0002

4. Fourth Ridge RNA [FR: PUCNUT]
   7. NHMTECFR97SC0004

5. Fourth Ridge RNA [FR: CALLON-CARINO]
   8. NHMTECFR97SC0005

6. Limber Pine RNA [LP: STCO-BOGR-CAFI]
   9. NHMTECCR97SC0001 10. NHMTECCR97SC0002 11. NHMTECCR97BH0003

7. Limber Pine RNA [LP: RHUARO/PSESPI]
   12. NHMTECCR97SC0004

8. Limber Pine RNA [LP: JUNSCO/PSESPI]
   13. NHMTECCR97SC0003

9. Limber Pine RNA [LP: CHRNAU/ERIPAU]
14. NHMTECCR97BH0001

10. Limber Pine RNA [LP: CALLON-CARINO]
15. NHMTECCR97BH0002

11. Limber Pine RNA [P: JUNHOR/PSESPI]
16. NHMTECCR97BH0004

LAKE MASON NWR

12. Lake Mason RNA [LM: PASSMI]
17. NHMTECLM97SC0001 18. NHMTECLM97SC0006

13. Lake Mason RNA [LM: PASSMI-NASVIR]
19. NHMTECLM97SC0003 20. NHMTECLM97SC0004

14. Lake Mason RNA [LM: SARVER/PASSMI]
21. NHMTECLM97SC0002

15. Lake Mason RNA [LM: ATRGAR/PASSMI]
22. NHMTECLM97SC0005

MEDICINE LAKE NWR (not all RNAs on refuge are represented by sample plots)

16. Big Island RNA [BI: STCO/BOGR/CAFI]
23. NHMTECRA97SC0007

17. Big Island RNA [BI: PASM-BOGR-CAFI]
24. NHMTECRA97SC0008

18. Tepee Hills RNA [TH: STICUR-ELYLAN]
25. NHMTECRA97SC0002

19. Tepee Hills RNA [TH: STCO-BOGR-CAFI]
26. NHMTECRA97SC0001

20. Medicine Lake Sandhills [ML: STICOM ALLIANCE]
27. NHMTECRA97SC0004 28. NHMTECRA97SC0005 29. NHMTECRA97SC0006

21. Medicine Lake Sandhills [ML: ELACOM/STICOM]
30. NHMTECRA97SC0003

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	1	1	2	2	2	3	4	5	6	6	6	7	8	9	10
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Trees:															
JUNSCO	---	---	---	---	---	2	---	10	---	---	---	3	60	---	---
Shrubs:															
ARTCAN	---	---	---	---	---	---	---	---	2	1	---	1	---	---	1
ARTFRI	3	3	1	---	---	1	---	---	1	1	1	---	---	---	---
ARTTSW	---	---	18	23	3	18	1	---	---	---	---	---	---	---	---
ATRCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRCON	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
ATRGAR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CERLAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CHRNAU	---	---	---	---	1	---	---	---	---	---	---	---	---	10	---
ELACOM	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GUTSAR	2	1	---	2	---	1	---	---	---	---	---	---	---	1	---
JUNHOR	---	---	---	---	---	---	---	---	---	---	---	---	10	---	---
LEPPUN	---	---	1	---	---	1	---	---	---	---	---	---	---	---	---
PRUVIR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RHUARO	---	---	1	---	1	---	---	---	---	---	---	8	1	---	---
RIBAUR	---	---	---	---	---	---	---	---	---	---	---	---	---	1	1
RIBCER	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
ROSARK	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
ROSWOO	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
SARVER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SYMOCC	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
YUCGLA	---	---	---	---	---	---	---	---	---	---	---	8	---	1	1
Graminoids:															
AGRCRI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AGRDAS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AGRINT	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---
AGRSMI	7	30	40	1	60	33	1	1	---	3	---	1	1	---	1
AGRSPI	---	---	1	---	---	---	---	---	---	1	---	10	4	10	3
AGRTRA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ANDHAL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ARILON	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
BOUGRA	---	---	---	---	---	---	---	---	1	---	1	1	---	---	1
BROJAP	1	---	---	1	---	---	---	---	---	1	---	---	---	---	---
CALLON	---	---	---	---	---	---	---	1	---	---	---	2	1	---	10
CALMON	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
CAREX	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CARFIL	---	---	24	---	---	1	---	---	45	20	20	---	1	---	---
CARHEL	---	---	---	---	---	---	---	35	---	1	---	---	---	---	---
CARINO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CARPEN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CARROS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	1	1	2	2	2	3	4	5	6	6	6	7	8	9	10
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Graminoids Continued:															
CARSTE	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CYPSCH	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DISSTR	---	---	---	---	---	---	3	---	---	---	---	---	---	1	---
ELYCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FESOCT	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
KOEMAC	23	23	1	---	---	3	---	---	1	---	3	---	1	---	---
MUHCUS	---	---	1	---	---	1	---	---	---	1	---	1	---	---	1
ORYHYM	---	---	---	---	---	1	---	---	---	1	---	1	---	---	1
ORYMIC	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
PASSMI	---	---	---	---	---	---	---	---	4	---	---	---	---	---	---
POACUS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POAJUN	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
POAPRA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POASAN	---	---	---	---	---	---	---	---	1	1	---	---	---	---	---
POASEC	---	---	3	1	---	---	---	---	---	---	10	---	---	---	---
PUCNUT	---	---	---	---	---	---	40	---	---	---	---	---	---	---	---
SCHSCO	---	---	---	---	---	---	---	3	---	---	---	1	---	---	1
SITHYS	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
SPOCRY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
STICOM	37	---	---	---	---	---	---	---	60	60	40	---	---	---	1
STICUR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
STIVIR	---	20	1	1	3	1	---	---	---	---	---	---	---	---	---
Forbs:															
ACHMIL	1	1	1	---	---	6	---	---	---	1	---	---	1	---	---
ALLTEX	---	---	1	1	1	1	1	---	---	---	---	---	---	---	---
ALYDES	---	---	---	1	---	1	1	---	---	---	---	---	---	---	---
ANDSEP	---	---	---	---	---	---	---	---	2	1	---	---	---	---	---
ANEPAT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ANTCOR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ANTENN	---	---	---	---	---	1	---	---	1	---	---	---	---	---	---
ANTPAR	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
ARABIS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ARAHOL	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ARTCAM	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
ARTDRA	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
ARTLON	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
ARTLUD	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASCSPE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASCVER	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
ASCVIR	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
ASTAGR	---	---	---	---	---	---	---	---	---	---	1	---	1	---	---
ASTBIS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASTCER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASTER	---	---	---	---	1	---	---	1	---	---	---	---	---	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	1	1	2	2	2	3	4	5	6	6	6	7	8	9	10
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Forbs Continued:															
ASTFAL	1	---	---	---	---	1	---	---	---	---	---	---	---	---	---
ASTKEN	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
ASTLOT	---	---	---	---	---	---	---	---	1	---	---	---	1	---	---
ASTMIS	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ASTPEC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASTRAG	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRHOR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRIPL	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
ATRSUC	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
CALELE	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
CALNUT	---	---	1	---	---	---	---	---	1	---	---	---	---	---	---
CAMROT	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
CAMSAT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CERARV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CHADOU	---	---	---	---	---	---	---	---	---	---	---	1	---	1	---
CHELEP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CHENOP	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
CHEPRA	---	---	---	---	---	---	---	---	1	---	---	1	---	---	---
CHRVIL	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
CIRUND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
COLLIN	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
COMUMB	---	---	1	1	1	1	---	---	---	---	---	---	---	---	---
CONARV	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
CONCAN	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
CORVIV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CRYCEL	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
DALCAN	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---
DALPUR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DESCUR	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DESPIN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DESSOP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DRABA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ECHANG	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ERICER	---	---	---	---	---	---	---	---	---	---	---	1	---	---	1
ERIFLA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ERIPAU	---	---	---	---	1	---	---	3	---	---	---	---	---	10	---
ERIPUM	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ERYASP	---	---	---	---	---	---	---	---	1	---	1	---	---	---	---
ERYREP	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
EUPSER	---	---	---	1	---	1	---	---	1	---	---	1	---	---	---
GAIARI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GALBOR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GAUCOC	---	---	---	---	---	---	---	---	1	1	1	1	---	1	1
GAYDIF	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---
GEUTRI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	1	1	2	2	2	3	4	5	6	6	6	7	8	9	10
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Forbs Continued:															
GILCON	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
GLYLEP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GRISQU	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
HACFLO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HAPSPI	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
HEDHIS	---	---	---	---	---	---	---	---	2	1	1	---	---	---	---
HELANN	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
HELIAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HELPET	---	---	---	1	---	---	---	---	---	---	---	---	---	---	1
HETVIL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HEUPAR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HEURIC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HYMFIL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
IRIMIS	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
IVAAXI	2	3	---	---	---	---	2	---	---	---	---	---	---	---	---
LACCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LACSER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LACTUC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LEPPER	---	---	---	---	---	---	---	---	---	1	---	1	---	---	---
LESLUD	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LESQUE	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---
LIAPUN	---	---	---	---	---	---	---	1	---	1	---	---	---	---	---
LINPER	---	---	---	---	---	---	---	---	1	1	---	---	---	---	---
LINRIG	---	---	1	---	---	---	---	---	1	---	---	---	---	---	---
LITARV	---	---	---	---	1	---	---	---	---	---	---	1	---	---	---
LITINC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LUPLEP	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
LYGJUN	---	---	---	---	---	---	---	---	1	---	1	---	---	---	---
MEDSAT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MELOFF	---	---	1	3	---	1	---	1	---	---	---	---	---	---	---
MENLAE	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
MIRABI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
MUSDIV	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---
OENCES	---	---	---	---	---	---	---	---	1	---	---	1	---	---	---
OENSER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
OPUFRA	1	---	---	---	---	---	---	1	1	1	---	---	---	---	---
OPUPOL	1	---	1	1	1	1	---	1	1	1	1	---	---	---	---
OROFAS	---	---	---	1	---	1	---	---	---	---	---	---	---	1	---
OROLUD	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
OXYTRO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PARPEN	---	---	---	---	---	1	---	1	---	---	---	---	---	---	---
PARSES	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PENNIT	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
PENSTE	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PETCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	1	3

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	1	1	2	2	2	3	4	5	6	6	6	7	8	9	10
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Forbs Continued:															
PETPUR	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
PHALIN	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
PHLALY	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PHLAND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PHLHOO	1	1	1	---	---	1	---	---	---	---	1	---	---	---	---
PHLOX	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PHYSAR	---	---	---	---	---	---	---	---	---	---	---	---	---	1	1
PICOPP	6	1	---	---	---	---	---	---	---	---	---	---	---	---	---
PLALAN	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
PLAPAT	---	---	---	---	---	---	---	---	1	1	---	---	---	---	---
POLALB	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POLAVI	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
POLERE	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
POLYGO	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---
POTENT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POTPEN	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
PSOARG	---	---	---	---	---	---	---	---	3	1	---	---	---	---	---
PSOESC	---	---	---	---	---	1	---	---	---	---	1	---	---	---	---
PSOLAN	---	---	---	---	---	---	---	---	---	---	---	2	1	---	1
RATCOL	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---
RUMVEN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SENCAN	---	1	---	---	---	---	---	---	---	---	---	---	1	---	---
SENINT	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---
SENPLA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SMISTE	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
SOLCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SOLMIS	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
SOLMOL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SOLNAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SOLNEM	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
SONARV	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
SPHCOC	3	1	1	---	---	---	---	---	3	1	---	---	---	---	---
STERUN	---	---	---	---	---	---	---	1	---	---	---	---	---	1	1
TAROFF	---	---	---	---	---	---	---	1	1	---	---	---	1	---	---
THERHO	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
TRADUB	---	1	---	---	---	---	---	---	---	---	---	1	---	---	---
TRAMIS	---	---	---	1	1	---	---	---	8	1	1	---	---	---	---
TRAOCC	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
VICAME	1	---	2	1	1	1	---	---	---	1	---	1	---	---	---
VIONUT	---	---	---	---	---	1	---	---	---	---	---	---	1	---	---
Ferns & Allied Forms:															
EQULAE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SELDEN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community / Site	11 * 16	12 * 17	12 * 18	13 * 19	13 * 20	14 * 21	15 * 22	16 * 23	17 * 24	18 * 25	19 * 26	20 * 27	20 * 28	20 * 29	21 * 30
Trees:															
JUNSCO	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Shrubs:															
ARTCAN	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ARTFRI	1	---	---	1	4	---	---	1	3	1	4	---	---	1	---
ARTTSW	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRCAN	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
ATRCON	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRGAR	---	---	---	---	---	---	8	---	---	---	---	---	---	---	---
CERLAN	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
CHRNAU	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ELACOM	---	---	---	---	---	---	---	---	---	---	---	---	---	---	13
GUTSAR	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
JUNHOR	75	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LEPPUN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PRUVIR	1	---	---	---	---	---	---	---	---	---	---	1	1	---	---
RHUARO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RIBAUR	3	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RIBCER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ROSARK	---	---	---	---	---	---	---	---	---	4	---	---	1	---	1
ROSWOO	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SARVER	---	---	---	---	---	20	---	---	---	---	---	---	---	---	---
SYMOCC	1	---	---	---	---	---	---	---	---	1	---	---	3	---	1
YUCGLA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Graminoids:															
AGRCRI	---	---	---	4	---	---	---	1	---	---	1	---	---	---	---
AGRDAS	---	---	---	---	---	---	---	---	---	---	7	---	---	---	---
AGRINT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AGRSMI	---	73	80	50	33	80	40	3	22	---	1	---	---	---	---
AGRSPI	10	---	---	---	---	---	---	---	---	---	---	---	---	---	---
AGRTRA	---	---	---	---	---	---	---	---	---	---	---	---	3	---	---
ANDHAL	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
ARILON	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BOUGRA	---	---	---	1	1	---	---	40	1	3	60	---	---	1	3
BROJAP	---	20	2	4	3	33	---	---	---	---	---	---	---	---	---
CALLON	---	---	---	---	---	---	---	---	---	1	---	2	3	30	3
CALMON	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CAREX	---	---	---	---	---	---	---	---	---	---	---	---	3	---	---
CARFIL	1	---	---	1	---	---	---	30	---	1	7	---	---	1	---
CARHEL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CARINO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
CARPEN	---	---	---	---	---	---	---	---	---	4	---	---	---	---	---
CARROS	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
CARSTE	---	---	---	---	---	---	---	1	50	1	1	---	1	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	11	12	12	13	13	14	15	16	17	18	19	20	20	20	21
Site	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Graminoids Continued:															
CYPSCH	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
DISSTR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ELYCAN	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---
FESOCT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
KOEMAC	1	---	---	---	12	---	---	1	---	---	3	---	1	---	---
MUHCUS	---	---	---	---	---	---	---	---	---	---	3	---	---	---	---
ORYHYM	1	---	---	---	---	---	---	---	---	---	---	20	---	---	---
ORYMIC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PASSMI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POACUS	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
POAJUN	---	---	1	---	---	1	---	---	---	---	---	---	---	---	---
POAPRA	---	---	---	1	---	---	---	---	---	---	---	---	1	---	---
POASAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POASEC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PUCNUT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SCHSCO	---	---	---	---	---	---	---	---	---	3	---	---	---	---	---
SITHYS	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---
SPOCRY	---	---	---	---	---	---	---	---	---	---	---	8	---	---	---
STICOM	1	---	---	20	20	---	---	50	30	---	10	---	73	60	70
STICUR	---	---	---	---	---	---	---	---	---	60	---	---	---	---	---
STIVIR	---	---	---	23	40	---	---	---	---	---	1	---	---	---	1
Forbs:															
ACHMIL	1	---	---	---	---	---	---	1	---	1	---	---	---	---	---
ALLTEX	---	---	---	---	---	---	1	1	1	---	---	---	---	---	---
ALYDES	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ANDSEP	---	---	---	---	---	---	---	---	10	1	---	---	---	---	1
ANEPAT	---	---	---	---	---	---	---	---	---	12	---	---	---	---	---
ANTCOR	---	---	---	---	---	---	---	---	---	1	---	---	1	---	---
ANTENN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ANTPAR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ARABIS	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ARAHOL	---	---	---	1	1	---	---	1	---	---	---	---	1	1	1
ARTCAM	---	---	---	---	---	---	---	---	---	1	---	---	1	1	---
ARTDRA	---	---	---	---	---	---	---	1	---	---	---	---	---	1	1
ARTLON	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ARTLUD	---	---	---	---	---	---	---	---	---	---	---	---	1	---	1
ASCSPE	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
ASCVER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASCVIR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASTAGR	1	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ASTBIS	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---
ASTCER	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
ASTER	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ASTFAL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASTKEN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	11	12	12	13	13	14	15	16	17	18	19	20	20	20	21
Site	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Forbs Continued:															
ASTLOT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ASTMIS	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
ASTPEC	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
ASTRAG	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ATRHOR	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRIPL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ATRSUC	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CALELE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CALNUT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CAMROT	1	---	---	---	---	---	---	---	---	1	---	---	---	---	---
CAMSAT	---	1	---	1	1	---	---	---	---	---	---	---	---	---	---
CERARV	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
CHADOU	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CHELEP	---	---	---	---	---	---	---	1	1	---	---	---	---	---	1
CHENOP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CHEPRA	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CHRVIL	---	---	---	---	---	---	---	---	---	1	---	1	---	1	1
CIRUND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
COLLIN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
COMUMB	---	---	---	---	---	---	---	---	---	1	---	---	---	1	---
CONARV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CONCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CORVIV	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
CRYCEL	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DALCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DALPUR	---	---	---	---	---	---	---	---	---	1	---	---	1	---	---
DESCUR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
DESPIN	---	---	1	1	---	3	---	---	---	---	---	---	---	---	---
DESSOP	---	3	---	---	---	---	---	---	1	---	---	---	---	---	1
DRABA	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
ECHANG	---	---	---	---	---	---	---	---	---	3	---	---	---	---	---
ERICER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ERIFLA	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
ERIPAU	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ERIPUM	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ERYASP	---	---	---	1	---	---	---	---	---	1	---	---	1	---	---
ERYREP	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
EUPSER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GAIARI	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
GALBOR	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
GAUCOC	---	---	---	---	---	---	---	---	---	1	1	---	---	---	---
GAYDIF	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GEUTRI	1	---	---	---	---	---	---	---	---	1	---	---	---	---	---
GILCON	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GLYLEP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
GRISQU	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community	11	12	12	13	13	14	15	16	17	18	19	20	20	20	21
Site	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Forbs Continued:															
HACFLO	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---
HAPSPI	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
HEDHIS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HELANN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HELIAN	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
HELPET	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HETVIL	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
HEUPAR	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
HEURIC	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HYMFIL	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
IRIMIS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
IVAAXI	---	13	3	1	1	3	10	---	---	---	---	---	---	---	---
LACCAN	---	10	1	1	1	2	1	---	---	---	---	---	---	---	---
LACSER	---	---	---	---	---	---	---	1	---	---	---	---	1	---	---
LACTUC	---	3	---	---	---	---	---	---	---	---	---	---	---	---	---
LEPPER	---	---	---	---	---	1	3	---	---	---	---	---	---	---	---
LESLUD	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
LESQUE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LIAPUN	---	---	---	---	---	---	---	---	---	1	---	---	1	1	---
LINPER	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LINRIG	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LITARV	1	---	---	---	---	---	---	---	---	---	---	---	1	---	1
LITINC	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
LUPLEP	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---
LYGJUN	---	---	---	---	---	---	---	1	1	---	---	---	---	1	---
MEDSAT	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---
MELOFF	---	---	---	---	---	---	1	---	---	1	---	---	---	---	---
MENLAE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MIRABI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MUSDIV	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
OENCES	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
OENSER	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
OPUFRA	---	---	---	---	1	---	---	1	---	---	---	---	1	1	---
OPUPOL	---	---	---	1	1	---	---	1	1	---	---	---	---	---	1
OROFAS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
OROLUD	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
OXYTRO	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
PARPEN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PARSES	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
PENN1T	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PENSTE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PETCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PETPUR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PHALIN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PHLALY	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PHLAND	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1

Appendix D. Cover Synthesis Table for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Community / Site	11 * 16 *	12 * 17 *	12 * 18 *	13 * 19 *	13 * 20 *	14 * 21 *	15 * 22 *	16 * 23 *	17 * 24 *	18 * 25 *	19 * 26 *	20 * 27 *	20 * 28 *	20 * 29 *	21 * 30 *
Forbs Continued:															
PHLHOO	---	---	---	---	---	---	---	---	---	1	4	---	---	---	---
PHLOX	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---
PHYSAR	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PICOPP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PLALAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PLAPAT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POLALB	---	---	---	---	---	---	---	---	---	1	3	---	---	---	---
POLAVI	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POLERE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POLYGO	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
POTENT	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
POTPEN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PSOARG	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PSOESC	---	---	---	---	---	---	---	---	---	1	1	---	---	---	---
PSOLAN	---	---	---	---	---	---	---	---	---	---	---	26	3	1	25
RATCOL	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
RUMVEN	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
SENCAN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SENINT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SENPLA	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SMISTE	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---
SOLCAN	---	---	---	---	---	---	---	---	---	1	---	---	1	---	---
SOLMIS	---	---	---	---	---	---	---	---	---	---	---	---	3	1	---
SOLMOL	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
SOLNAN	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
SOLNEM	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---
SONARV	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
SPHCOC	---	---	---	---	2	---	---	1	1	---	1	---	---	---	---
STERUN	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TAROFF	---	1	1	1	1	2	1	---	---	---	---	---	---	---	---
THERHO	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TRADUB	---	3	---	---	1	2	1	1	---	---	---	---	---	1	---
TRAMIS	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
TRAOCC	---	---	---	---	---	---	---	---	---	---	---	---	1	---	1
VICAME	1	---	---	1	1	---	---	1	1	---	---	---	---	---	---
VIONUT	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Ferns & Allied Forms:															
EQULAE	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
SELDEN	---	---	---	---	---	---	---	20	---	---	---	---	---	---	---

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abund) [Range, Minimum - Maximum]

Community * MT: PASSMI-NASVIR *	FR: ARTTSW/PASSMI *	FR: JUNSCO/ARTTSW *	FR: PUCNUT *	FR: CALLON-CARINO *
# Sites * N = 2 *	N = 3 *	N = 1 *	N = 1 *	N = 1 *
Trees:				
JUNSCO	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (2) [2 - 2]	0 (0) [0 - 0]	100 (10) [10 - 10]
Shrubs:				
ARTCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTFRI	100 (3) [3 - 3]	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTTSW	0 (0) [0 - 0]	100 (15) [3 - 23]	100 (18) [18 - 18]	100 (1) [1 - 1]	0 (0) [0 - 0]
ATRCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRCON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRGAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRNAU	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ELACOM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GUTSAR	100 (2) [1 - 2]	33 (2) [2 - 2]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
JUNHOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPUN	0 (0) [0 - 0]	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
PRUVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RHUARO	0 (0) [0 - 0]	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBAUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBCER	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ROSARK	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ROSWOO	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SARVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SYMOCC	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
YUCGLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Graminoids:				
AGRCRI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRDAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRINT	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRSMI	100 (19) [7 - 30]	100 (34) [1 - 60]	100 (33) [33 - 33]	100 (1) [1 - 1]	100 (1) [1 - 1]
AGRSPI	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRTRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANDHAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARILON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
BOUGRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
BROJAP	50 (1) [1 - 1]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALLON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
CALMON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]

Appendix D. Cover/Consttancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abund) [Range, Minimum - Maximum]

Community # Sites	MT: PASSMI-NASVIR N = 2	FR: ARTTSW/PASSMI N = 3	FR: JUNSCO/ARTTSW N = 1	FR: PUCNUT N = 1	FR: CALLON-CARINO N = 1
Graminoids Continued:					
CAREX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARFIL	0 (0) [0 - 0]	33 (24) [24 - 24]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARHEL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (35) [35 - 35]
CARINO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARROS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARSTE	50 (10) [10 - 10]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CYPSCH	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DISSTR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]	0 (0) [0 - 0]
ELYCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
FESOCT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
KOEMAC	100 (23) [23 - 23]	33 (1) [1 - 1]	100 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]
MUHCUS	0 (0) [0 - 0]	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ORYHYM	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ORYMIC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PASSMI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POACUS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POAJUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
POAPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASEC	0 (0) [0 - 0]	67 (2) [1 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PUCNUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (40) [40 - 40]	0 (0) [0 - 0]
SCHSCO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]
SITHYS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
SPOCRY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STICOM	50 (37) [37 - 37]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STICUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STIVIR	50 (20) [20 - 20]	100 (2) [1 - 3]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
Forbs:					
ACHMIL	100 (1) [1 - 1]	33 (1) [1 - 1]	100 (6) [6 - 6]	0 (0) [0 - 0]	0 (0) [0 - 0]
ALLTEX	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]
ALYDES	0 (0) [0 - 0]	33 (1) [1 - 1]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]
ANDSEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANEPAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTCOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTENN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARABIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abund) [Range, Minimum - Maximum]

Community * MT: PASSMI-NASVIR *	FR: ARTTSW/PASSMI *	FR: JUNSCO/ARTTSW *	FR: PUCNUT *	FR: CALLON-CARINO *
# Sites * N = 2 *	N = 3 *	N = 1 *	N = 1 *	N = 1 *
Forbs Continued:				
ARAHOL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTCAM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTDRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTLON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ARTLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCSPE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTAGR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTBIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTER	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ASTFAL	50 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTKEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTLOT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTPEC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTRAG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRHOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRIPL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
ATRSUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
CALELE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALNUT	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMROT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHADOU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHELEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHENOP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
CHEPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CIRUND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COLLIN	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COMUMB	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CORVIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CRYCEL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abund) [Range, Minimum - Maximum]

Community # Sites	MT: PASSMI-NASVIR N = 2	FR: ARTTSW/PASSMI N = 3	FR: JUNSCO/ARTTSW N = 1	FR: PUCNUT N = 1	FR: CALLON-CARINO N = 1
Forbs Continued:					
DESCUR	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESPIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESSOP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DRABA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ECHANG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERICER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIFLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIPAU	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]
ERIPUM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYASP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYREP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
EUPSER	0 (0) [0 - 0]	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAIARI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GALBOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAUCOC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAYDIF	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GEUTRI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GILCON	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
GLYLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GRISQU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
HACFLO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HAPSPI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEDHIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELANN	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELIAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELPET	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HETVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEUPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEURIC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HYMFIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
IRIMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
IVAAXI	100 (3) [2 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (2) [2 - 2]	0 (0) [0 - 0]
LACCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACTUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESQUE	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LIAPUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
LINPER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abund) [Range, Minimum - Maximum]

Community * MT: PASSMI-NASVIR *	FR: ARTTSW/PASSMI *	FR: JUNSCO/ARTTSW *	FR: PUCNUT *	FR: CALLON-CARINO *
# Sites * N = 2 *	N = 3 *	N = 1 *	N = 1 *	N = 1 *
Forbs Continued:				
LINRIG	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LITARV	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LITINC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LUPLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LYGJUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MEDSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MELOFF	0 (0) [0 - 0]	67 (2) [1 - 3]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]
MENLAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MIRABI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MUSDIV	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENCES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OPUFRA	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
OPUPOL	50 (1) [1 - 1]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]
OROFAS	0 (0) [0 - 0]	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
OROLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OXYTRO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]
PARSES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENNIT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENSTE	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHALIN	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLALY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLAND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLHOO	100 (1) [1 - 1]	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLOX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHYSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PICOPP	100 (4) [1 - 6]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLALAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLAPAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLALB	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLAVI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLERE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
POLYGO	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTENT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOARG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOESC	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abund) [Range, Minimum - Maximum]

Community # Sites	MT: PASSMI-NASVIR N = 2	FR: ARTTSW/PASSMI N = 3	FR: JUNSCO/ARTTSW N = 1	FR: PUCNUT N = 1	FR: CALLON-CARINO N = 1
Forbs Continued:					
PSOLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RATCOL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
RUMVEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENCAN	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENINT	0 (0) [0 - 0]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENPLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SMISTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLMOL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNEM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SONARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SPHCOC	100 (2) [1 - 3]	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STERUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
TAROFF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
THERHO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
TRADUB	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRAMIS	0 (0) [0 - 0]	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRAOCC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
VICAME	50 (1) [1 - 1]	100 (1) [1 - 2]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
VIONUT	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
Ferns & Allied Forms:					
EQULAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SELDEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community * # Sites *	LP:STCO-BOGR-CAFI * N = 3	LP:RHUARO/PSESPI * N = 1	LP:JUNSCO/PSESPI * N = 1	LP:CHRNAU/ERIPAU * N = 1	LP:CALLON-CARINO * N = 1
Trees:					
JUNSCO	0 (0) [0 - 0]	100 (3) [3 - 3]	100 (60) [60 - 60]	0 (0) [0 - 0]	0 (0) [0 - 0]
Shrubs:					
ARTCAN	67 (2) [1 - 2]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ARTFRI	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTTSW	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRCON	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRGAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRNAU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (10) [10 - 10]	0 (0) [0 - 0]
ELACOM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GUTSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
JUNHOR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (10) [10 - 10]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PRUVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RHUARO	0 (0) [0 - 0]	100 (8) [8 - 8]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBAUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]
RIBCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ROSARK	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ROSWOO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SARVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SYMOCC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
YUCGLA	0 (0) [0 - 0]	100 (8) [8 - 8]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]
Graminoids:					
AGRCRI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRDAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRINT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRSMI	33 (3) [3 - 3]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]
AGRSPI	33 (1) [1 - 1]	100 (10) [10 - 10]	100 (4) [4 - 4]	100 (10) [10 - 10]	100 (3) [3 - 3]
AGRTRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANDHAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARILON	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
BOUGRA	67 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
BROJAP	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALLON	0 (0) [0 - 0]	100 (2) [2 - 2]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (10) [10 - 10]
CALMON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAREX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:STCO-BOGR-CAFI N = 3	LP:RHUARO/PSESPI N = 1	LP:JUNSCO/PSESPI N = 1	LP:CHRNAU/ERIPAU N = 1	LP:CALLON-CARINO N = 1
Graminoids Continued:					
CARFIL	100 (28) [20 - 45]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARHEL	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARINO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARROS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARSTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CYPSCH	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DISSTR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
ELYCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
FESOCT	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
KOEMAC	67 (2) [1 - 3]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
MUHCUS	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ORYHYM	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ORYMIC	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
PASSMI	33 (4) [4 - 4]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POACUS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POAJUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POAPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASAN	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASEC	33 (10) [10 - 10]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PUCNUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SCHSCO	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
SITHYS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SPOCRY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STICOM	100 (53) [40 - 60]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
STICUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STIVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Forbs:					
ACHMIL	33 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ALLTEX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ALYDES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANDSEP	67 (2) [1 - 2]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANEPAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTCOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTENN	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARABIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARAHOL	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTCAM	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:STCO-BOGR-CAFI N = 3	LP:RHUARO/PSESPI N = 1	LP:JUNSCO/PSESPI N = 1	LP:CHRNAU/ERIPAU N = 1	LP:CALLON-CARINO N = 1
Forbs Continued:					
ARTDRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
ARTLON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCSPE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVER	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVIR	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTAGR	33 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTBIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTFAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTKEN	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTLOT	33 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTMIS	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTPEC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTRAG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRHOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRIPL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRSUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALELE	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALNUT	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMROT	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHADOU	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
CHELEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHENOP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHEPRA	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRVIL	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CIRUND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
COLLIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COMUMB	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONARV	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONCAN	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CORVIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CRYCEL	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALCAN	0 (0) [0 - 0]	100 (2) [2 - 2]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESCUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESPIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community *	LP:STCO-BOGR-CAFI *	LP:RHUARO/PSESPI *	LP:JUNSCO/PSESPI *	LP:CHRNAU/ERIPAU *	LP:CALLON-CARINO *
# Sites *	N = 3 *	N = 1 *	N = 1 *	N = 1 *	N = 1 *
Forbs Continued:					
DESSOP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DRABA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ECHANG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERICER	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ERIFLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIPAU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (10) [10 - 10]	0 (0) [0 - 0]
ERIPUM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYASP	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYREP	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
EUPSER	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAIARI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GALBOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAUCOC	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]
GAYDIF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GEUTRI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GILCON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GLYLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GRISQU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HACFLO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HAPSPI	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEDHIS	100 (1) [1 - 2]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELANN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELIAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELPET	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
HETVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEUPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEURIC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HYMFIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
IRIMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
IVAAXI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACTUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPER	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESQUE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LIAPUN	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LINPER	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LINRIG	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LITARV	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:STCO-BOGR-CAFI N = 3	LP:RHUARO/PSESPI N = 1	LP:JUNSCO/PSESPI N = 1	LP:CHRNAU/ERIPAU N = 1	LP:CALLON-CARINO N = 1
Forbs Continued:					
LITINC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LUPLEP	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LYGJUN	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MEDSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MELOFF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MENLAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
MIRABI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
MUSDIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENCES	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OPUFRA	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OPUPOL	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OROFAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
OROLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
OXYTRO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARSES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENNIT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
PENSTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (3) [3 - 3]
PETPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
PHALIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLALY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLAND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLHOO	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLOX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHYSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]
PICOPP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLALAN	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLAPAT	67 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLALB	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLAVI	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLERE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLYGO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTENT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTPEN	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOARG	67 (2) [1 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOESC	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOLAN	0 (0) [0 - 0]	100 (2) [2 - 2]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]
RATCOL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:STCO-BOGR-CAFI N = 3	LP:RHUARO/PSESPI N = 1	LP:JUNSCO/PSESPI N = 1	LP:CHRNAU/ERIPAU N = 1	LP:CALLON-CARINO N = 1
Forbs Continued:					
RUMVEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENINT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENPLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SMISTE	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLMOL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNEM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
SONARV	33 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SPHCOC	67 (2) [1 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STERUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]
TAROFF	33 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
THERHO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRADUB	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRAMIS	100 (3) [1 - 8]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRAOCC	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
VICAME	33 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
VIONUT	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
Ferns & Allied Forms:					
EQULAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SELDEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:JUNHOR/PSESPI N = 1	LM:PASSMI N = 2	LM:PASSMI-NASVIR N = 2	LM:SARVER/PASSMI N = 1	LM:ATRGAR/PASSMI N = 1
Trees:					
JUNSCO	100 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Shrubs:					
ARTCAN	100 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTFRI	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (3) [1 - 4]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTTSW	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRCON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRGAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (8) [8 - 8]
CERLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRNAU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ELACOM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GUTSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
JUNHOR	100 (75) [75 - 75]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PRUVIR	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RHUARO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBAUR	100 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ROSARK	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ROSWOO	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SARVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (20) [20 - 20]	0 (0) [0 - 0]
SYMOCC	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
YUCGLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Grasses					
AGRCRI	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (4) [4 - 4]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRDAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRINT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRSMI	0 (0) [0 - 0]	100 (77) [73 - 80]	100 (42) [33 - 50]	100 (80) [80 - 80]	100 (40) [40 - 40]
AGRSPI	100 (10) [10 - 10]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRTRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANDHAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARILON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
BOUGRA	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
BROJAP	0 (0) [0 - 0]	100 (11) [2 - 20]	100 (4) [3 - 4]	100 (33) [33 - 33]	0 (0) [0 - 0]
CALLON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALMON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAREX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:JUNHOR/PSESPI N = 1	LM:PASSMI N = 2	LM:PASSMI-NASVIR N = 2	LM:SARVER/PASSMI N = 1	LM:ATRGAR/PASSMI N = 1
Graminoids Continued:					
CARFIL	100 (1) [1 - 1]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARHEL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARINO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARROS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARSTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CYPSCH	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DISSTR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ELYCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
FESOCT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
KOEMAC	100 (1) [1 - 1]	0 (0) [0 - 0]	50 (12) [12 - 12]	0 (0) [0 - 0]	0 (0) [0 - 0]
MUHCUS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ORYHYM	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ORYMIC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PASSMI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POACUS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POAJUN	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
POAPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASEC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PUCNUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SCHSCO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SITHYS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
SPOCRY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STICOM	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (20) [20 - 20]	0 (0) [0 - 0]	0 (0) [0 - 0]
STICUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
STIVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (32) [23 - 40]	0 (0) [0 - 0]	0 (0) [0 - 0]
Forbs:					
ACHMIL	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ALLTEX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
ALYDES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANDSEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANEPAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTCOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTENN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARABIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARAHOL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTCAM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:JUNHOR/PSESPI N = 1	LM:PASSMI N = 2	LM:PASSMI-NASVIR N = 2	LM:SARVER/PASSMI N = 1	LM:ATRGAR/PASSMI N = 1
Forbs Continued:					
ARTDRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTLON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCSPE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTAGR	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTBIS	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTFAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTKEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTLOT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTPEC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTRAG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRHOR	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRIPL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRSUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALELE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALNUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMROT	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMSAT	0 (0) [0 - 0]	50 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHADOU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHELEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHENOP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHEPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CIRUND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COLLIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COMUMB	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CORVIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CRYCEL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESCUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESPIN	0 (0) [0 - 0]	50 (1) [1 - 1]	50 (1) [1 - 1]	100 (3) [3 - 3]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community	LP:JUNHOR/PSESPI	LM:PASSMI	LM:PASSMI-NASVIR	LM:SARVER/PASSMI	LM:ATRGAR/PASSMI
# Sites	N = 1	N = 2	N = 2	N = 1	N = 1
Forbs Continued:					
DESSOP	0 (0) [0 - 0]	50 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DRABA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ECHANG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERICER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIFLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIPAU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIPUM	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYASP	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYREP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
EUPSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAIARI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GALBOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAUCOC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAYDIF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GEUTRI	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GILCON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GLYLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GRISQU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HACFLO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HAPSPI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEDHIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELANN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELIAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELPET	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HETVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEUPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEURIC	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HYMFIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
IRIMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
IVAAXI	0 (0) [0 - 0]	100 (8) [3 - 13]	100 (1) [1 - 1]	100 (3) [3 - 3]	100 (10) [10 - 10]
LACCAN	0 (0) [0 - 0]	100 (6) [1 - 10]	100 (1) [1 - 1]	100 (2) [2 - 2]	100 (1) [1 - 1]
LACSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACTUC	0 (0) [0 - 0]	50 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (3) [3 - 3]
LESLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESQUE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LIAPUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LINPER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LINRIG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LITARV	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:JUNHOR/PSESPI N = 1	LM:PASSMI N = 2	LM:PASSMI-NASVIR N = 2	LM:SARVER/PASSMI N = 1	LM:ATRGAR/PASSMI N = 1
Forbs Continued:					
LITINC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LUPLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LYGJUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MEDSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
MELOFF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]
MENLAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MIRABI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MUSDIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENCES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OPUFRA	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
OPUPOL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
OROFAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OROLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OXYTRO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARSES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENNIT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENSTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHALIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLALY	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLAND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLHOO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLOX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHYSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PICOPP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLALAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLAPAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLALB	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLAVI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLERE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLYGO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTENT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOARG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOESC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RATCOL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	LP:JUNHOR/PSESPI N = 1	LM:PASSMI N = 2	LM:PASSMI-NASVIR N = 2	LM:SARVER/PASSMI N = 1	LM:ATRGAR/PASSMI N = 1
Forbs Continued:					
RUMVEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENINT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENPLA	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SMISTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLMOL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNEM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SONARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SPHCOC	0 (0) [0 - 0]	0 (0) [0 - 0]	50 (2) [2 - 2]	0 (0) [0 - 0]	0 (0) [0 - 0]
STERUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TAROFF	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]	100 (2) [2 - 2]	100 (1) [1 - 1]
THERHO	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRADUB	0 (0) [0 - 0]	50 (3) [3 - 3]	50 (1) [1 - 1]	100 (2) [2 - 2]	100 (1) [1 - 1]
TRAMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRAOCC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
VICAME	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
VIONUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Ferns & Allied Forms:					
EQULAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SELDEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	BI:STCO-BOGR-CAFI N = 1	BI:PASM-BOGR-CARI N = 1	TH:STICUR-ELYLAN N = 1	TH:STCO-BOGR-CAFI N = 1	ML:STICOM ALLIANCE N = 3
Trees:					
JUNSCO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Shrubs:					
ARTCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTFRI	100 (1) [1 - 1]	100 (3) [3 - 3]	100 (1) [1 - 1]	100 (4) [4 - 4]	33 (1) [1 - 1]
ARTTSW	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
ATRCON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRGAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
CHRNAU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ELACOM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GUTSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
JUNHOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PRUVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	67 (1) [1 - 1]
RHUARO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBAUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
RIBCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ROSARK	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (4) [4 - 4]	0 (0) [0 - 0]	33 (1) [1 - 1]
ROSWOO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SARVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SYMOCC	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	33 (3) [3 - 3]
YUCGLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Grasses					
AGRCRI	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
AGRDAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (7) [7 - 7]	0 (0) [0 - 0]
AGRINT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRSMI	100 (3) [3 - 3]	100 (22) [22 - 22]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
AGRSPI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
AGRTRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (3) [3 - 3]
ANDHAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
ARILON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
BOUGRA	100 (40) [40 - 40]	100 (1) [1 - 1]	100 (3) [3 - 3]	100 (60) [60 - 60]	33 (1) [1 - 1]
BROJAP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALLON	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (12) [2 - 30]
CALMON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAREX	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (3) [3 - 3]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	BI:STCO-BOGR-CARI N = 1	BI:PASM-BOGR-CARI N = 1	TH:STICUR-ELYLAN N = 1	TH:STCO-BOGR-CARI N = 1	ML:STICOM ALLIANCE N = 3
Graminoids Continued:					
CARFIL	100 (30) [30 - 30]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (7) [7 - 7]	33 (1) [1 - 1]
CARHEL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARINO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (4) [4 - 4]	0 (0) [0 - 0]	0 (0) [0 - 0]
CARROS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
CARSTE	100 (1) [1 - 1]	100 (50) [50 - 50]	100 (1) [1 - 1]	100 (1) [1 - 1]	33 (1) [1 - 1]
CYPSCH	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
DISSTR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ELYCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (2) [2 - 2]
FESOCT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
KOEMAC	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]	33 (1) [1 - 1]
MUHCUS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]	0 (0) [0 - 0]
ORYHYM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (20) [20 - 20]
ORYMIC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PASSMI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POACUS	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POAJUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POAPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
POASAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POASEC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PUCNUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SCHSCO	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]
SITHYS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SPOCRY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (8) [8 - 8]
STICOM	100 (50) [50 - 50]	100 (30) [30 - 30]	0 (0) [0 - 0]	100 (10) [10 - 10]	67 (67) [60 - 73]
STICUR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (60) [60 - 60]	0 (0) [0 - 0]	0 (0) [0 - 0]
STIVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
Forbs:					
ACHMIL	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ALLTEX	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ALYDES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANDSEP	0 (0) [0 - 0]	100 (10) [10 - 10]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANEPAT	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (12) [12 - 12]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTCOR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	33 (1) [1 - 1]
ANTENN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ANTPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARABIS	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARAHOL	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	67 (1) [1 - 1]
ARTCAM	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	67 (1) [1 - 1]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	BI:STCO-BOGR-CAFI N = 1	BI:PASM-BOGR-CARI N = 1	TH:STICUR-ELYLAN N = 1	TH:STCO-BOGR-CAFI N = 1	ML:STICOM ALLIANCE N = 3
Forbs Continued:					
ARTDRA	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
ARTLON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ARTLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
ASCSPE	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASCVIR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTAGR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTBIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTCER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
ASTER	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTFAL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTKEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTLOT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ASTPEC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
ASTRAG	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRHOR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRIPL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ATRSUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALELE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CALNUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMROT	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CAMSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CERARV	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHADOU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHELEP	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHENOP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHEPRA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CHRVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	67 (1) [1 - 1]
CIRUND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COLLIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
COMUMB	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	33 (1) [1 - 1]
CONARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CONCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
CORVIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
CRYCEL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DALPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	33 (1) [1 - 1]
DESCUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DESPIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community *	BI:STCO-BOGR-CAFI *	BI:PASM-BOGR-CARI *	TH:STICUR-ELYLAN *	TH:STCO-BOGR-CAPI *	ML:STICOM ALLIANCE *
# Sites *	N = 1 *	N = 1 *	N = 1 *	N = 1 *	N = 3 *
Forbs Continued:					
DESSOP	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
DRABA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
ECHANG	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (3) [3 - 3]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERICER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIFLA	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIPAU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERIPUM	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
ERYASP	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	33 (1) [1 - 1]
ERYREP	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
EUPSER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAIARI	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
GALBOR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
GAUCOC	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]
GAYDIF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GEUTRI	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
GILCON	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GLYLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
GRISQU	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HACFLO	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HAPSPI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
HEDHIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELANN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELIAN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
HELPET	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HETVIL	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
HEUPAR	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
HEURIC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
HYMFIL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
IRIMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
IVAAXI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LACSER	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
LACTUC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LEPPER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
LESQUE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LIAPUN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	67 (1) [1 - 1]
LINPER	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LINRIG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
LITARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	BI:STCO-BOGR-CAFI N = 1	BI:PASM-BOGR-CARI N = 1	TH:STICUR-ELYLAN N = 1	TH:STCO-BOGR-CAFI N = 1	ML:STICOM ALLIANCE N = 3
Forbs Continued:					
LITINC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
LUPLEP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
LYGJUN	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
MEDSAT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MELOFF	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
MENLAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MIRABI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
MUSDIV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
OENCES	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OENSER	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
OPUFRA	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	67 (1) [1 - 1]
OPUPOL	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OROFAS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OROLUD	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
OXYTRO	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PARSES	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENNIT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PENSTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PETPUR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHALIN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLALY	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLAND	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHLHOO	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (4) [4 - 4]	0 (0) [0 - 0]
PHLOX	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PHYSAR	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PICOPP	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLALAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PLAPAT	0 (0) [0 - 0]	0 (0) [0.- 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLALB	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (3) [3 - 3]	0 (0) [0 - 0]
POLAVI	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLERE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POLYGO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTENT	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
POTPEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOARG	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
PSOESC	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]
PSOLAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (10) [1 - 26]
RATCOL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	BI:STCO-BOGR-CAFI N = 1	BI:PASM-BOGR-CARI N = 1	TH:STICUR-ELYLAN N = 1	TH:STCO-BOGR-CAFI N = 1	ML:STICOM ALLIANCE N = 3
Forbs Continued:					
RUMVEN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
SENCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENINT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SENPLA	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SMISTE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
SOLCAN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	33 (1) [1 - 1]
SOLMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	67 (2) [1 - 3]
SOLMOL	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNAN	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SOLNEM	0 (0) [0 - 0]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]
SONARV	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SPHCOC	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	100 (1) [1 - 1]	0 (0) [0 - 0]
STERUN	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TAROFF	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
THERHO	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRADUB	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
TRAMIS	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
TRAOCC	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	33 (1) [1 - 1]
VICAME	100 (1) [1 - 1]	100 (1) [1 - 1]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
VIONUT	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
Ferns & Allied Forms:					
EQULAE	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]
SELDEN	100 (20) [20 - 20]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community # Sites	ML:ELACOM-STICOM N = 1
Trees:	
JUNSCO	0 (0) [0 - 0]
Shrubs:	
ARTCAN	0 (0) [0 - 0]
ARTFRI	0 (0) [0 - 0]
ARTTSW	0 (0) [0 - 0]
ATRCAN	0 (0) [0 - 0]
ATRCON	0 (0) [0 - 0]
ATRGAR	0 (0) [0 - 0]
CERLAN	0 (0) [0 - 0]
CHRNAU	0 (0) [0 - 0]
ELACOM	100 (13) [13 - 13]
GUTSAR	0 (0) [0 - 0]
JUNHOR	0 (0) [0 - 0]
LEPPUN	0 (0) [0 - 0]
PRUVIR	0 (0) [0 - 0]
RHUARO	0 (0) [0 - 0]
RIBAUR	0 (0) [0 - 0]
RIBCER	0 (0) [0 - 0]
ROSARK	100 (1) [1 - 1]
ROSWOO	0 (0) [0 - 0]
SARVER	0 (0) [0 - 0]
SYMOCC	100 (1) [1 - 1]
YUCGLA	0 (0) [0 - 0]
Grasses	
AGRCRI	0 (0) [0 - 0]
AGRDAS	0 (0) [0 - 0]
AGRINT	0 (0) [0 - 0]
AGRSMI	0 (0) [0 - 0]
AGRSPI	0 (0) [0 - 0]
AGRTRA	0 (0) [0 - 0]
ANDHAL	0 (0) [0 - 0]
ARILON	0 (0) [0 - 0]
BOUGRA	100 (3) [3 - 3]
BROJAP	0 (0) [0 - 0]
CALLON	100 (3) [3 - 3]
CALMON	0 (0) [0 - 0]
CAREX	0 (0) [0 - 0]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community * ML:ELACOM-STICOM *	
# Sites * N = 1 *	
Graminoids Continued:	
CARFIL	0 (0) [0 - 0]
CARHEL	0 (0) [0 - 0]
CARINO	100 (1) [1 - 1]
CARPEN	0 (0) [0 - 0]
CARROS	0 (0) [0 - 0]
CARSTE	0 (0) [0 - 0]
CYPSCH	0 (0) [0 - 0]
DISSTR	0 (0) [0 - 0]
ELYCAN	0 (0) [0 - 0]
FESOCT	0 (0) [0 - 0]
KOEMAC	0 (0) [0 - 0]
MUHCUS	0 (0) [0 - 0]
ORYHYM	0 (0) [0 - 0]
ORYMIC	0 (0) [0 - 0]
PASSMI	0 (0) [0 - 0]
POACUS	0 (0) [0 - 0]
POAJUN	0 (0) [0 - 0]
POAPRA	0 (0) [0 - 0]
POASAN	0 (0) [0 - 0]
POASEC	0 (0) [0 - 0]
PUCNUT	0 (0) [0 - 0]
SCHSCO	0 (0) [0 - 0]
SITHYS	0 (0) [0 - 0]
SPOCRY	0 (0) [0 - 0]
STICOM	100 (70) [70 - 70]
STICUR	0 (0) [0 - 0]
STIVIR	100 (1) [1 - 1]
Forbs	
ACHMIL	0 (0) [0 - 0]
ALLTEX	0 (0) [0 - 0]
ALYDES	0 (0) [0 - 0]
ANDSEP	100 (1) [1 - 1]
ANEPAT	0 (0) [0 - 0]
ANTCOR	0 (0) [0 - 0]
ANTENN	0 (0) [0 - 0]
ANTPAR	0 (0) [0 - 0]
ARABIS	0 (0) [0 - 0]
ARAHOL	100 (1) [1 - 1]

Appendix D. Cover/Constancy Matrices for selected community types sampled on US Fish & Wildlife Service Research Natural Areas

Constancy (Average Abundance) [Range, Minimum - Maximum]

Community * ML:ELACOM-STICOM *
Sites * N = 1 *

Forbs Continued:

ARTCAM	0 (0)	[0 -	0]
ARTDRA	100 (1)	[1 -	1]
ARTLON	0 (0)	[0 -	0]
ARTLUD	100 (1)	[1 -	1]
ASCSPE	0 (0)	[0 -	0]
ASCVER	0 (0)	[0 -	0]
ASCVIR	0 (0)	[0 -	0]
ASTAGR	0 (0)	[0 -	0]
ASTBIS	0 (0)	[0 -	0]
ASTCER	0 (0)	[0 -	0]
ASTER	0 (0)	[0 -	0]
ASTFAL	0 (0)	[0 -	0]
ASTKEN	0 (0)	[0 -	0]
ASTLOT	0 (0)	[0 -	0]
ASTMIS	0 (0)	[0 -	0]
ASTPEC	0 (0)	[0 -	0]
ASTRAG	0 (0)	[0 -	0]
ATRHOR	0 (0)	[0 -	0]
ATRIPL	0 (0)	[0 -	0]
ATRSUC	0 (0)	[0 -	0]
CALELE	0 (0)	[0 -	0]
CALNUT	0 (0)	[0 -	0]
CAMROT	0 (0)	[0 -	0]
CAMSAT	0 (0)	[0 -	0]
CERARV	0 (0)	[0 -	0]
CHADOU	0 (0)	[0 -	0]
CHELEP	100 (1)	[1 -	1]
CHENOP	0 (0)	[0 -	0]
CHEPRA	0 (0)	[0 -	0]
CHRVIL	100 (1)	[1 -	1]
CIRUND	0 (0)	[0 -	0]
COLLIN	0 (0)	[0 -	0]
COMUMB	0 (0)	[0 -	0]
CONARV	0 (0)	[0 -	0]
CONCAN	0 (0)	[0 -	0]
CORVIV	0 (0)	[0 -	0]
CRYCEL	0 (0)	[0 -	0]
DALCAN	0 (0)	[0 -	0]
DALPUR	0 (0)	[0 -	0]
DESCUR	0 (0)	[0 -	0]

Appendix E

Element Occurrence Records for Montana Plant Species of Special Concern

Scientific Name: CRYPTANTHA FENDLERI
Common Name: FENDLER CAT'S-EYE

Global rank: G4 Forest Service status:
State rank: S1 Federal Status:

Element occurrence code: PDBOR0A0X0.005
Element occurrence type:

Survey site name: MEDICINE LAKE SANDHILLS
EO rank:
EO rank comments:

County: SHERIDAN

USGS quadrangle: CAPENEYS LAKE

Township:	Range:	Section:	TRS comments:
031N	057E	20	SW4SW4

Precision: S
Survey date: Elevation: 2065 -
First observation: 1997-07-02 Slope/aspect: 20%
Last observation: 1997-07-02 Size (acres): 0

Location:
MEDICINE LAKE SANDHILLS. CA. 2 AIR MILES NORTHWEST OF BEVERLY SCHOOL.

Element occurrence data:
COMMON IN SMALL AREAS OF TWO OF THE MOST ACTIVE BLOWOUTS, A HIGHLY LOCALIZED HABITAT.

General site description:
UNSTABLE RIM OF OPEN SAND BLOWOUT HABITAT, WITH PSORALEA LANCEOLATA AND ORYZOPSIS HYMENOIDES.

Land owner/manager:
MEDICINE LAKE WILDERNESS
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
PRIVATELY OWNED LAND (INDIVIDUAL OR CORPORATE)

Comments:
THERE IS POTENTIAL HABITAT BETWEEN ELEMENT OCCURENCES 005 AND 003, AND THEY ARE LIKELY TO BE PART OF A COMPLEX POPULATION.

Information source: COOPER, S. V. AND B. L. HEIDEL. 1999. BIODIVERSITY INVENTORY AND REPRESENTATIVENESS ASSESSMENT OF RESEARCH NATURAL AREAS ON NATIONAL WILDLIFE REFUGES IN MONTANA. UNPUBLISHED REPORT TO U.S. FISH AND WILDLIFE SERVICE. MONTANA NATURAL HERITAGE PROGRAM, HELENA.

Specimens:

Scientific Name: CYPERUS SCHWEINITZII
Common Name: SCHWEINITZ' FLATSEDGE

Global rank: G5 Forest Service status:
State rank: S1 Federal Status:

Element occurrence code: PMCYP06360.001
Element occurrence type:

Survey site name: MEDICINE LAKE SANDHILLS
EO rank:
EO rank comments:

County: SHERIDAN

USGS quadrangle: SUNNYHILL SCHOOL
CAPENEYS LAKE

Township:	Range:	Section:	TRS comments:
031N	057E	24	13, 14, 20, 23, 26
031N	058E	7	18; 19

Precision: S
Survey date: -
First observation: 1943
Last observation: 1997-07-02
Elevation: 2100 -
Slope/aspect:
Size (acres): 0

Location:
MEDICINE LAKE SANDHILLS, SOUTHEAST OF MEDICINE LAKE, CA. 25 AIR MILES NORTH OF CULBERTSON.

Element occurrence data:
RHIZOMATOUS, MANY THOUSANDS OF STEMS IN SANDHILLS AREA.

General site description:
OPEN SAND HILLS; MOST CONSISTENTLY FOUND IN BLOWOUTS; WITH ORYZOPSIS HYMENOIDES, PSORALEA LANCEOLATA, STIPA COMATA, SPOROBOLUS CRYPTANDRUS, CRYPTANTHA FENDLERI.

Land owner/manager:
MEDICINE LAKE WILDERNESS
PRIVATELY OWNED LAND (INDIVIDUAL OR CORPORATE)
STATE LAND - UNDESIGNATED

Comments:

Information source: LESICA, PETER. REPORT TO THE NATURE CONSERVANCY. UNDATED.

Specimens: HOTCHKISS, N. (6869). 1943. MONT.

Scientific Name: PHACELIA THERMALIS
Common Name: HOT SPRING PHACELIA

Global rank: G3G4 Forest Service status:
State rank: S1 Federal Status:
Element occurrence code: PDHYD0C4L0.002
Element occurrence type:

Survey site name: YORK ISLAND
EO rank: BC
EO rank comments: PROTECTED EO OF LIMITED SIZE AND UNNATURAL HABITAT.
County: GARFIELD
USGS quadrangle: YORK ISLAND

Township:	Range:	Section:	TRS comments:
025N	041E	08	SW4; SW4NW4

Precision: S
Survey date: 1998-07-17 Elevation: 2250 -
First observation: 1978 Slope/aspect:
Last observation: 1998-07-17 Size (acres): 1
Location: YORK ISLAND, CHARLES M. RUSSELL NWR.

Element occurrence data:
CA. 50 PLANTS IN 3 SUBPOPULATIONS; THEY ARE OUTLIERS OF 1-2 INDIVIDUALS EXCEPT FOR THE SUBPOPULATION IN THE EASTERNMOST BACKWATER. IN FRUIT AND LATE FLOWER 17 JULY 1998.

General site description:
BEACHES OF REWORKED SHALE, AND EPHEMERALLY PONDED BACKWATERS SET OFF FROM FORT PECK RESERVOIR BY WRACK LINE OF SHALE FORMED BY WAVE ACTION. HIGHEST SPECIES NUMBERS ARE AT THE EDGE OF AN OPEN, EVAPORATED BACKWATER POOL SURROUNDED BY A ROBUST WEEDY COMMUNITY OF CHENOPODIUM, HELIANTHUS ANNUUS, AND LEPIDIUM SATIVUM.

Land owner/manager: CHARLES M. RUSSELL NATIONAL WILDLIFE REFUGE
YORK ISLAND RESEARCH NATURAL AREA

Comments:
ALMOST ALL SUITABLE HABITAT WAS SURVEYED IN 1998. THE RESERVOIR REACHED MAXIMUM POOL CAPACITY IN 1997. IN THE SPRING OF 1998 WATER LEVELS WERE LOW BUT HAVE RISEN 5 FEET WITH JUNE RAINS. THESE CHANGES AFFECT SPECIES BIOLOGY (DISPERSAL, ESTABLISHMENT) AS WELL AS HABITAT AVAILABILITY. OBSERVED BY B. HEIDEL, S. COOPER, AND G. GUENTHER IN 1998.

Information source: COOPER, S. V. AND B. L. HEIDEL. 1999. BIODIVERSITY INVENTORY AND REPRESENTATIVENESS ASSESSMENT OF RESEARCH NATURAL AREAS ON NATIONAL WILDLIFE REFUGES IN MONTANA. UNPUBLISHED REPORT TO U.S. FISH AND WILDLIFE SERVICE. MONTANA NATURAL HERITAGE PROGRAM

Specimens: LACKSCHEWITZ, K. H. (8248). 1978. SPECIMEN #81943. MONTU.

Scientific Name: PHLOX ANDICOLA
Common Name: PLAINS PHLOX

Global rank: G4 Forest Service status:
State rank: S2 Federal Status:

Element occurrence code: PDPLM0D080.006
Element occurrence type:

Survey site name: MEDICINE LAKE SANDHILLS
EO rank:
EO rank comments:

County: SHERIDAN

USGS quadrangle: CAPENEYS LAKE

Township:	Range:	Section:	TRS comments:
031N	057E	19	SW4SW4

Precision: S
Survey date: Elevation: 2000 -
First observation: 1997-07-02 Slope/aspect: 2-20%/NORTH
Last observation: 1997-07-03 Size (acres):

Location:
CA. 15 MILES SOUTH AND EAST OF MEDICINE LAKE (TOWN).

Element occurrence data:
LOCALLY COMMON IN ROLLING SANDPLAIN PLOT; OCCASIONAL IN ISLAND KNOLL PLOT. IN FRUIT IN JULY.

General site description:
VARIOUS WELL-DRAINED, EXPOSED SETTINGS.

Land owner/manager:
MEDICINE LAKE WILDERNESS
MEDICINE LAKE NATIONAL WILDLIFE REFUGE

Comments:
PRESUMED TO CORRESPOND WITH THE MATERIAL COLLECTED AND IDENTIFIED AS PHLOX ACULEATA SOUTH OF THE REFUGE IN SANDHILLS. DOCUMENTED IN ECODATA PLOTS.

Information source: COOPER, S. V. AND B. L. HEIDEL. 1999. BIODIVERSITY INVENTORY AND REPRESENTATIVENESS ASSESSMENT OF RESEARCH NATURAL AREAS ON NATIONAL WILDLIFE REFUGES IN MONTANA. UNPUBLISHED REPORT TO U.S. FISH AND WILDLIFE SERVICE. MONTANA NATURAL HERITAGE PROGRAM, HELENA.

Specimens:

Appendix F

Illustrations of Montana Plant Species of Special Concern

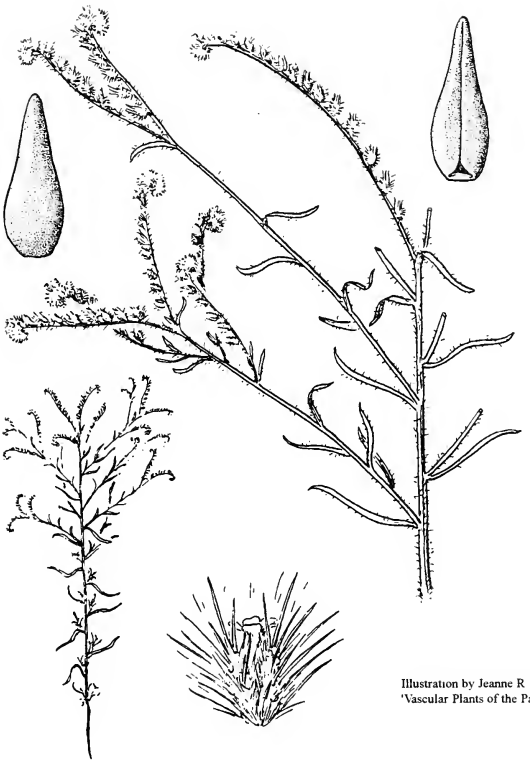


Illustration by Jeanne R. Janish, From 'Vascular Plants of the Pacific Northwest'

CRYPTANTHA FENDLERI
FENDLER CAT'S-EYE

Fendler Cat's-eye is an annual with simple or branched stems that are 5-20 cm high. The alternate, narrow, strap shaped leaves may be up to 3 cm long; those at the base are usually brown by the time the plant is fruiting. Foliage is sparsely covered with spreading hairs. Tiny, white flowers are borne on coiled stalks that unwind and elongate as flowering progresses from the base upward. The corolla is ca. 1 mm high and has a small, united portion below and 5 spreading petals above. The calyx is covered with stiff, straight hairs and becomes 4-6 mm long in fruit. Within each fruiting calyx are 4 smooth, shiny, narrowly lance-shaped nutlets that are ca. 1.5 mm long and 1/3 as wide; 1 or more of these may be missing. Flowering in May-early July.

Annual species of CRYPTANTHA are distinguished by characters of the seeds. C. FENDLERI is distinguished by having 4 smooth, shiny nutlets that are lance-shaped and 1/3 as wide as they are long. A hand lens or microscope are needed for positive identification.

CYPERUS SCHWEINITZII
SCHWEINITZ' FLATSEDGE

Schweinitz' Flatsedge is a grass-like perennial with stems that are 10-40 cm high, arising from short, irregularly swollen rhizomes. The leaves are 1-4 mm wide and located mostly near the base of the stem. The inflorescence is subtended by 3-6 long, leaf-like bracts, some of which are wider than the leaves. The inflorescence is made up of ascending clusters of flattened spikelets that are 5-25 mm long and borne on stalks that are very short to long. The flowers are crowded opposite each other and consist only of a small, pointed scale, that is ca. 3-4 mm long and subtends 3 stamens and an ovary. The seed is triangular in cross-section. Fruit mature in late June-July.

This is our only perennial CYPERUS and is the only one occurring in upland habitat.

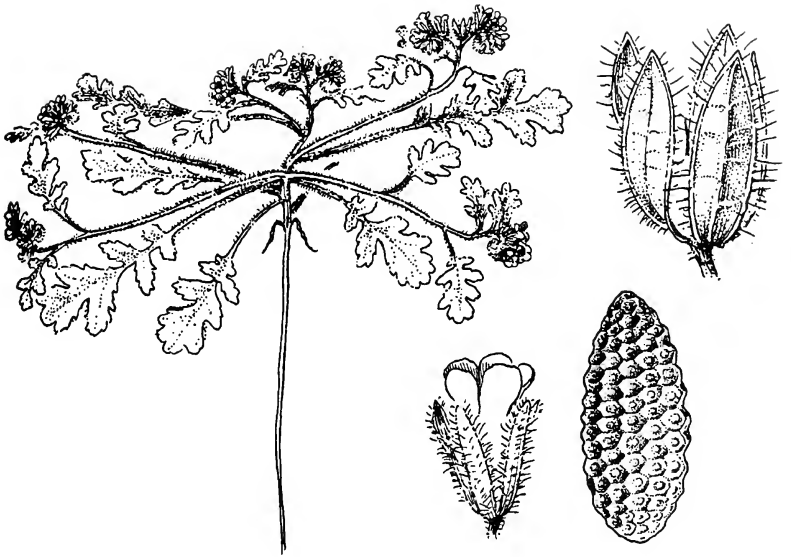


Illustration by Jeanne R. Janish,
From 'Vascular Plants of the Pacific Northwest'

PHACELIA THERMALIS
HOT SPRING PHACELIA

Hot Spring Phacelia is an annual that is branched from the base, with prostrate or ascending stems. The alternate leaves have broadly lance-shaped blades that are 1-9 cm long with toothed and deeply lobed margins and well-developed petioles. Foliage is glandular-hairy. The short-stalked flowers are borne in crowded, narrow, 1-sided, curved spikes that are up to 10 cm long. The spikes unwind as they mature and originate in the leaf axils. The lavendar to whitish flowers each have a 5 lobed tubular corolla that is 3-4 mm long and 5 narrowly lance-shaped, hairy sepals that are as long as the corolla in flower but twice as long in fruit. The stamens are included in the corolla tube. The fruit is a capsule with 2-4 seeds covered by a honeycomb pattern. Flowering in June.

PHACELIA IVESIANA differs from P. THERMALIS in that it has strap shaped sepals and is not as densely glandular-hairy. P. LUTEA has yellow flowers and only shallowly lobed leaves.

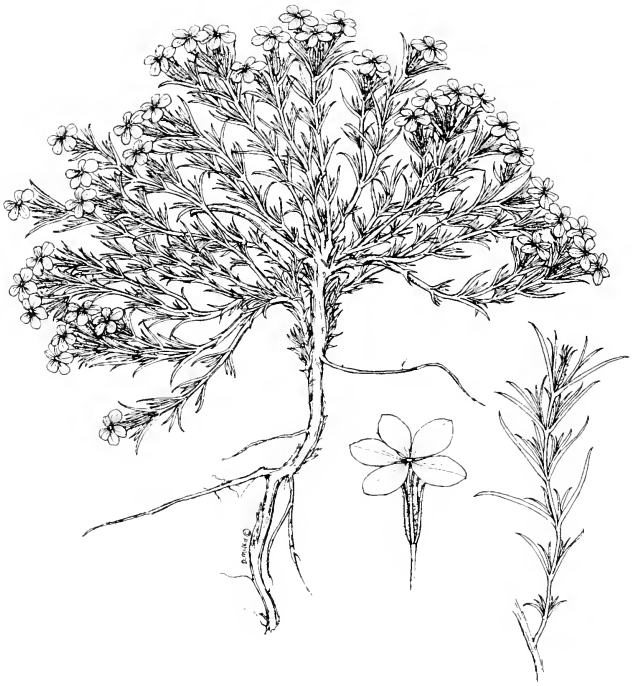


Illustration by Debbie McNiel

PHLOX ANDICOLA
PLAINS PHLOX

Plains Phlox is a perennial with loosely tufted stems that are 4-10 cm high arising from creeping rhizomes. The 5-8 pairs of opposite, linear leaves have prominent midveins and whitish bases and are 10-25 mm long, ca. 1 mm wide and come to a sharp point. Foliage is glabrous to sparsely hairy. Stems are white. 1-5 white flowers are borne at the stem tips. Each flower has 5 petals and a tubular corolla. The calyx is also tubular, with 5 lobes, tangled long hairs, and 6-11 mm length. Flowering in May-early June.

Distinguished from PHLOX HOODII by leaf length over 10 mm long, and from P. ALYSSIFOLIA by leaf width less than 2 mm wide. Flowers are needed for positive identification, and hybridization between these species is reported elsewhere in the range.

Appendix G

Vascular Plants Cited in This Report, by Common Names, Scientific Names, and Six-letter Acronyms

APPENDIX G.

TREES

Code	Scientific Name	Common Name
ABILAS	*Abies lasiocarpa*	Subalpine Fir
FRAPEN	*Fraxinus pennsylvanica*	Green Ash
JUNSCO	*Juniperus scopulorum*	Rocky Mountain Juniper
PICENG	*Picea engelmannii*	Engelmann Spruce
PINFLE	*Pinus flexilis*	Limber Pine
PINPON	*Pinus ponderosa*	Ponderosa Pine
POPDEL	*Populus deltoides*	Great Plains Cottonwood
POPTRE	*Populus tremuloides*	Quaking Aspen
PSEMEN	*Pseudotsuga menziesii*	Douglas-fir

SHRUBS

Code	Scientific Name	Common Name
AMEALN	*Amelanchier alnifolia*	Western Serviceberry
ARTCAN	*Artemisia cana* ssp. *cana*	Silver Sagebrush
ARTFRI	*Artemisia frigida*	Fringed Sagewort
ARTTSW	*Artemisia tridentata* ssp. *wyomingensis*	Wyoming Big Sagebrush
ATRCON	*Atriplex confertifolia*	Shadscale
ATRGAR	*Atriplex gardneri*	Gardner's Saltsage
BERREP	*Berberis repens*	Creeping Oregongrape
CERLAN	*Ceratoides lanata*	Winterfat
CHRNAU	*Chrysothamnus nauseosus*	Common Rabbitbrush
CHRVIS	*Chrysothamnus viscidiflorus*	Green Rabbitbrush
CLELIG	*Clematis ligusticifolia*	Western Virgins-bower
CLEOCC	*Clematis columbiana*	Columbia Clematis
CORSTO	*Cornus stolonifera*	Red-osier Dogwood
ELACOM	*Elaeagnus commutata*	Silverberry
GUTSAR	*Gutierrezia sarothrae*	Broom Snakeweed
JUNCOM	*Juniperus communis*	Common Juniper
JUNHOR	*Juniperus horizontalis*	Creeping Juniper
LEPPUN	*Leptodactylon pungens*	Prickly Phlox
LONUTA	*Lonicera utahensis*	Utah Honeysuckle
PRUVIR	*Prunus virginiana*	Common Chokecherry
RHUARO	*Rhus aromatica*	Fragrant Sumac
RIBAUR	*Ribes aureum*	Golden Currant
RIBCER	*Ribes cereum*	Squaw Currant
RIBLAC	*Ribes lacustre*	Swamp Currant
RIBMON	*Ribes montigenum*	Mountain Gooseberry
RIBSET	*Ribes setosum*	Missouri Gooseberry
RIBVIS	*Ribes viscosissimum*	Sticky Currant
ROSARK	*Rosa arkansana*	Arkansas Rose
ROSWOO	*Rosa woodsii*	Woods Rose
RUBPAR	*Rubus parviflorus*	Thimbleberry
SALEXI	*Salix exigua*	Sandbar Willow
SALLUT	*Salix lutea*	Watson Willow
SARVER	*Sarcobatus vermiculatus*	Black Greasewood
SHECAN	*Shepherdia canadensis*	Canada Buffaloberry
SPIBET	*Spiraea betulifolia*	Shiny-leaf Spiraea
SYMALB	*Symphoricarpos albus*	Common Snowberry
SYMOCC	*Symphoricarpos occidentalis*	Western Snowberry
SYMORE	*Symphoricarpos oreophilus*	Mountain Snowberry
TOXRYD	*Toxicodendron rydbergii*	Poison Ivy
YUCGLA	*Yucca glauca*	Yucca

GRAMINOIDS

Code	Scientific Name	Common Name
AGRCRI	*Agropyron cristatum*	Crested Wheatgrass
AGRINT	*Agropyron intermedium*	Intermediate Wheatgrass
AGROPY	*Agropyron spp.*	Wheatgrass
AGRREP	*Agropyron repens*	Quackgrass
AGRSMI	*Agropyron smithii* (= *Pascopyrum smithii*)	Western Wheatgrass
AGRSPI	*Agropyron spicatum* (= *Pseudoroegneria spicata*)	Bluebunch Wheatgrass
AGRTRA	*Agropyron trachycaulum* (= *Agropyron caninum*)	Bearded Wheatgrass
ANDHAL	*Andropogon hallii*	Sand Bluestem
ARILON	*Aristida longiseta*	Red Threeawn
ARIPUR	*Aristida purpurea* (= *Aristida longiseta*)	Red Threeawn
BOUGRA	*Bouteloua gracilis*	Blue Grama
BROINE	*Bromus inermis*	Smooth Brome
BROJAP	*Bromus japonicus*	Japanese Brome
BROTEC	*Bromus tectorum*	Cheatgrass
CALLON	*Calamovilfa longifolia*	Prairie Sandreed
CALMON	*Calamagrostis montanensis*	Plains Reedgrass
CALRUB	*Calamagrostis rubescens*	Pinegrass
CAREX	*Carex spp.*	Sedge
CARFIL	*Carex filifolia*	Thread-leaved Sedge
CARHEL	*Carex heliophila* (= *Carex pensylvanica*)	Sun Sedge
CARINO	*Carex inops* (= *Carex pensylvanica*)	Long-stolon Sedge
CARPEN	*Carex pensylvanica*	Long-stolon Sedge
CARROS	*Carex rostrata* (= *Carex utriculata*)	Beaked Sedge
CARSTE	*Carex stenophylla*	Narrow-leaved Sedge
CYPSCH	*Cyperus schweinitzii*	Schweinitz's Flatsedge
DISSTR	*Distichlis stricta* (= *Distichlis spicata*)	Alkali Saltgrass
ELYCAN	*Elymus canadensis*	Canada Wildrye
ELYTRA	*Elymus trachycaulus* (= *Agropyron caninum*)	Bearded Wheatgrass
FESIDA	*Festuca idahoensis*	Idaho Fescue
FESOCT	*Festuca octoflora*	Six-weeks Fescue
HORJUB	*Hordeum jubatum*	Foxtail Barley
KOEMAC	*Koeleria macrantha* (= *Koleria cristata*)	Prairie Junegrass
MUHCUS	*Muhlenbergia cuspidata*	Plains Muhly
ORYASP	*Oryzopsis asperifolia*	Roughleaf Ricegrass
ORYHYM	*Oryzopsis hymenoides*	Indian Ricegrass
ORYMIC	*Oryzopsis micrantha*	Little-seed Ricegrass
PASSMI	*Pascopyrum smithii*	Western Wheatgrass
POACOM	*Poa compressa*	Canada Bluegrass
POACUS	*Poa cusickii* (= *Poa fendleriana*)	Cusick's Bluegrass
POAINT	*Poa interior* (= *Poa glauca*)	Inland Bluegrass
POAJUN	*Poa juncifolia* (= *Poa secunda*)	Alkali Bluegrass
POAPRA	*Poa pratensis*	Kentucky Bluegrass
POAREF	*Poa reflexa*	Nodding Bluegrass
POASAN	*Poa sandbergii* (= *Poa secunda*)	Sandberg's Bluegrass
POASEC	*Poa secunda*	Sandberg's Bluegrass
PSESPI	*Pseudoroegneria spicata*	Bluebunch Wheatgrass
PUCNUT	*Puccinellia nuttalliana*	Nuttall's Alkaligrass
SCHPAN	*Schedonnardus paniculatus*	Tumblegrass
SCHSCO	*Schizachyrium scoparium* (= *Andropogon scoparius*)	Little Bluestem
SITHYS	*Sitanion hystrix*	Bottlebrush Squirreltail
SPOCRY	*Sporobolus cryptandrus*	Sand Dropseed
STICOM	*Stipa comata*	Needle-and-thread
STICUR	*Stipa curtiseta*	Porcupine Needlegrass
STIVIR	*Stipa viridula* (= *Nasella viridula*)	Green Needlegrass

FORBS

Code	Scientific Name	Common Name
ACHMIL	*Achillea millefolium*	Common Yarrow
AGOGLA	*Agoseris glauca*	Pale Agoseris
ALLCER	*Allium cernuum*	Nodding Onion
ALLIUM	*Allium spp.*	Onion
ALLTEX	*Allium textile*	Textile Onion
ALYDES	*Alyssum desertorum*	Desert Alyssum
ANDSEP	*Androsace septentrionalis*	Northern Fairy-candelabra
ANEMON	*Anemone spp.*	Anemone
ANEPAT	*Anemone patens*	Pasqueflower
ANTCOR	*Antennaria corymbosa*	Meadow Pussy-toes
ANTENN	*Antennaria spp.*	Everlasting Pussy-toes
ANTMIC	*Antennaria microphylla*	Rosy Pussy-toes
ANTPAR	*Antennaria parvifolia*	Nuttall's Pussy-toes
APOCYN	*Apocynum spp.*	Dogbane
APOSIB	*Apocynum sibiricum*	Clasping-leaved Dogbane
AQUILE	*Aquilegia spp.*	Columbine
ARABIS	*Arabis spp.*	Rockcress
ARAGLA	*Arabis glabra*	Towermustard
ARAHIR	*Arabis hirsuta*	Hairy Rockcress
ARAHOL	*Arabis holboellii*	Holboell's Rockcress
ARNCOR	*Amica cordifolia*	Heart-leaf Arnica
ARTCAM	*Artemisia campestris*	Pacific Sagewort
ARTDRA	*Artemisia dracunculus*	Tarragon
ARTLON	*Artemisia longifolia*	Long-leaved Sagewort
ARTLUD	*Artemisia ludoviciana*	Prairie Sagewort
ASCSPE	*Asclepias speciosa*	Showy Milkweed
ASCVER	*Asclepias verticillata*	Whorled Milkweed
ASCVIR	*Asclepias viridiflora*	Green Milkweed
ASTADS	*Astragalus adsurgens*	Standing Milk-vetch
ASTAGR	*Astragalus agrestis*	Field Milk-vetch
ASTBIS	*Astragalus bisulcatus*	Two-Groove Milk-vetch
ASTCER	*Astragalus ceramicus*	Painted Milk-vetch
ASTCON	*Aster conspicuus*	Showy Aster
ASTDRU	*Astragalus drummondii*	Drummond's Milk-vetch
ASTER	*Aster spp.*	Aster
ASTFAL	*Aster falcatus*	White-prairie Aster
ASTFLE	*Astragalus flexuosus*	Wiry Milk-vetch
ASTGIL	*Astragalus gilviflorus*	Plains Orophaca
ASTKEN	*Astragalus kentrophyta*	Thistle Milk-vetch
ASTLAE	*Aster laevis*	Smooth Aster
ASTLOT	*Astragalus lotiflorus*	Lotus Milk-vetch
ASTMIO	*Astragalus missouriensis*	Missouri Milk-vetch
ASTMIS	*Astragalus miser*	Weedy Milk-vetch
ASTPAN	*Aster pansus*	Tufted White Prairie Aster
ASTPEC	*Astragalus pectinatus*	Tine-leaved Milk-vetch
ASTPER	*Aster perelegans*	Elegant Aster
ASTPUR	*Astragalus purshii*	Pursh's Milk-vetch
ASTRAG	*Astragalus spp.*	Milk-vetch
ATRHOR	*Atriplex hortensis*	Garden Orache
ATRIPL	*Atriplex spp.*	Saltbush
ATRROS	*Atriplex rosea*	Red Orache
ATRSUC	*Atriplex suckleyi (= Atriplex dioica)*	Rillscale
BAHOPP	*Bahia oppositifolia*	Plains Bahia
BUPAME	*Bupleurum americanum*	American Thorough-wax
CALELE	*Calochortus elegans*	Northwest Mariposa
CALELE	*Caloplaca elegans (=Xanthoria elegans)*	
CALNUT	*Calochortus nuttallii*	Sego-lilly
CAMROT	*Campanula rotundifolia*	Harebell
CAMSAT	*Camelina sativa*	Gold-of-pleasure
CASLIN	*Castilleja linariifolia*	Narrow-leaved Paintbrush
CENREP	*Centaurea repens*	Russian Knapweed
CERARV	*Cerastium arvense*	Field Chickweed
CHADOU	*Chaenactis douglasii*	Hoary Chaenactis
CHEALB	*Chenopodium album*	Lambsquarter
CHEBOT	*Chenopodium botrys*	Jerusalem-oak Goosefoot
CHEGIG	*Chenopodium gigantospermum*	Maple-leaved Goosefoot
CHELEP	*Chenopodium leptophyllum*	Slimleaf Goosefoot
CHENOP	*Chenopodium spp.*	Goosefoot

FORBS

Code	Scientific Name	Common Name
CHEPRA	*Chenopodium pratericola*	Slimleaf Goosefoot
CHRVIL	*Chrysopsis villosa*	Hairy Golden-aster
CIRARV	*Cirsium arvense*	Canada Thistle
CIRUND	*Cirsium undulatum*	Wavy-leaved Thistle
CLESER	*Cleome serrulata*	Rocky Mountain Bee Plant
COLLIN	*Collomia linearis*	Narrow-leaf Collomia
COMUMB	*Comandra umbellata*	Bastard Toad-flax
CONARV	*Convolvulus arvensis*	Field Morning-glory
CONCAN	*Conyza canadensis*	Horseweed
CONORI	*Conringia orientalis*	Mustard Hare's Ear
CORMIS	*Coryphantha missouriensis*	Nipple Coryphantha
CREACU	*Crepis acuminata*	Tapertip Hawksbeard
CREPIS	*Crepis spp.*	Hawksbeard
CRYCEL	*Cryptantha celosioides*	Northern Cryptantha
CYMBIP	*Cymopterus bipinnatus*	Hayden's Cymopterus
CYMGLA	*Cymopterus glaucus*	Grayish Cymopterus
CYMHEN	*Cymopterus hendersonii*	Henderson's Cymopterus
DALCAN	*Dalea candida*	White Prairie-clover
DALPUR	*Dalea purpurea*	Purple Prairie-clover
DESCUR	*Descurainia spp.*	Tansymustard
DESPIN	*Descurainia pinnata*	Pinnate Tansymustard
DESRIC	*Descurainia richardsonii*	Richardson's Tansymustard
DESSOP	*Descurainia sophia*	Flixweed Tansymustard
DOUMON	*Douglasia montana*	Rocky Mountain Douglasia
DRAOLI	*Draba oligosperma*	Few-seeded Draba
ECHANG	*Echinacea angustifolia*	Pale Purple Coneflower
EPIANG	*Epilobium angustifolium*	Fireweed
ERICAE	*Erigeron caespitosus*	Tufted Fleabane
ERICER	*Eriogonum cernuum*	Nodding Wild Buckwheat
ERICOM	*Erigeron compositus*	Cut-leaved Daisy
ERIFLA	*Eriogonum flavum*	Yellow Buckwheat
ERIPAU	*Eriogonum pauciflorum*	Few-flowered Wild Buckwheat
ERIPUM	*Erigeron pumilus*	Shaggy Fleabane
ERIUMB	*Eriogonum umbellatum*	Sulfur Buckwheat
ERYASP	*Erysimum asperum*	Plains Wallflower
ERYREP	*Erysimum repandum*	Spreading Wallflower
EUPROB	*Euphorbia robusta*	Rocky Mountain Spurge
EUPSER	*Euphorbia serpyllifolia*	Thyme-leaf Spurge
FILARV	*Filago arvensis*	Field Filago
FRASPE	*Frasera speciosa*	Giant Frasera
FRAVES	*Fragaria vesca*	Woods Strawberry
GAIARI	*Gaillardia aristata*	Blanket-flower
GALBOR	*Galium boreale*	Northern Bedstraw
GALIUM	*Galium spp.*	Bedstraw
GAUCOC	*Gaura coccinea*	Scarlet Gaura
GAYDIF	*Gayophytum diffusum*	Spreading Groundsmoke
GERVIS	*Geranium viscosissimum*	Sticky Geranium
GEUTRI	*Geum triflorum*	Prairie Smoke
GILCON	*Gilia congesta* (= *Ipomopsis congesta*)	Ballhead Gilia
GLYLEP	*Glycyrrhiza lepidota*	American Licorice
GOOOBL	*Goodyera oblongifolia*	Western Rattlesnake-plantain
GRISQU	*Grindelia squarrosa*	Curlycup Gumweed
HACDEF	*Hackelia deflexa*	Nodding Stickseed
HACFLO	*Hackelia floribunda*	Showy Stickseed
HAPACA	*Haplopappus acaulis*	Cushion Goldenweed
HAPSPI	*Haplopappus spinulosus*	Spiny Goldenweed
HEDDRU	*Hedeoma drummondii*	Drummond False Pennyroyal
HEDHIS	*Hedeoma hispida*	Rough Pennyroyal
HELANN	*Helianthus annuus*	Common Sunflower
HELIAN	*Helianthus spp.*	Sunflower
HELPET	*Helianthus petiolaris*	Prairie Sunflower
HETVIL	*Heterotheca villosa* (= *Chrysopsis villosa*)	Hairy Golden-aster
HEUPAR	*Heuchera parvifolia*	Small-leaved Alumroot
HEURIC	*Heuchera richardsonii*	Richardson's Alumroot
HYMFIL	*Hymenopappus filifolius*	Columbia Cut-leaf
IRIMIS	*Iris missouriensis*	Rocky Mountain Iris

FORBS

Code	Scientific Name	Common Name
IVAAXI	*Iva axillaris*	Poverty-weed
LACCAN	*Lactuca canadensis*	Wild Lettuce
LACSER	*Lactuca serriola*	Prickly Lettuce
LACTUC	*Lactuca spp.*	Lettuce
LEPDEN	*Lepidium densiflorum*	Prairie Pepperweed
LEPPER	*Lepidium perfoliatum*	Clasping Pepperweed
LEPSAT	*Lepidium sativum*	Garden Cress
LEPSAT	*Leptogium saturnium*	
LESLUD	*Lesquerella ludoviciana*	Silvery Bladderpod
LESQUE	*Lesquerella spp.*	Bladderpod
LIAPUN	*Liatris punctata*	Dotted Blazing-star
LINLEW	*Linum lewisii (=Linum perenne)*	Wild Blue Flax
LINPER	*Linum perenne*	Blue Flax
LINRIG	*Linum rigidum*	Yellow Flax
LITARV	*Lithospermum arvense*	Corn Gromwell
LITINC	*Lithospermum incisum*	Yellow Gromwell
LUPARG	*Lupinus argenteus*	Silvery Lupine
LUPLEP	*Lupinus lepidus*	Prairie Lupine
LYGJUN	*Lygodesmia juncea*	Rush-like Skeletonweed
MACCAN	*Machaeranthera canescens*	Hoary Aster
MACGRI	*Machaeranthera grindelioides*	Nuttall's Goldenweed
MEDLUP	*Medicago lupulina*	Black Medic
MEDSAT	*Medicago sativa*	Alfalfa
MELALB	*Melanelia albertana*	
MELALB	*Melilotus alba*	White Sweet-clover
MELOFF	*Melilotus officinalis*	Yellow Sweet-clover
MIRABI	*Mirabilis spp.*	Four-o'clock
MONFIS	*Monarda fistulosa*	Horsemint
MUSDIV	*Musineon divaricatum*	Leafy Musineon
OENCES	*Oenothera cespitosa*	Desert Evening-primrose
OENSER	*Oenothera serrulata (= Oenothera rhombipetala)*	Shrubby Evening-primrose
OPUFRA	*Opuntia fragilis*	Brittle Prickly-pear
OPUPOL	*Opuntia polyacantha*	Plains Prickly-pear
OROFAS	*Orobanche fasciculata*	Clustered Broomrape
OROLUD	*Orobanche ludoviciana*	Suksdorf's Broomrape
ORTLUT	*Orthocarpus luteus*	Yellow Owl-clover
OSMCHI	*Osmorhiza chilensis*	Mountain Sweet-cicely
OXYCAM	*Oxytropis campestris*	Slender Crazyweed
OXYLAM	*Oxytropis lambertii*	Purple Locoweed
OXYTRO	*Oxytropis spp.*	Crazyweed
PARPEN	*Parietaria pensylvanica*	Pennsylvania Pellitory
PARSES	*Paronychia sessiliflora*	Stemless Whitlow-wort
PENPRO	*Penstemon procerus*	Small-flowered Penstemon
PENSTE	*Penstemon spp.*	Penstemon
PETCAN	*Petalostemon candidum (= Dalea candida)*	White Prairie-clover
PHACEL	*Phacelia spp.*	Phacelia
PHAFRA	*Phacelia franklinii*	Franklin's Phacelia
PHALIN	*Phacelia linearis*	Threadleaf Phacelia
PHLALY	*Phlox alyssifolia*	Alyssum-leaved Phlox
PHLAND	*Phlox andicola*	Moss Phlox
PHLHOO	*Phlox hoodii*	Hood's Phlox
PHLMUL	*Phlox multiflora*	Many-flowered Phlox
PHLOX	*Phlox spp.*	Phlox
PHYSAR	*Physaria spp.*	Twinpod
PICOPP	*Picradeniopsis oppositifolia*	Plains Bahia
PLAARI	*Plantago aristata*	Large-bracted Plantain
PLAELO	*Plantago elongata*	Slender Plantain
PLALAN	*Plantago lanceolata*	Buckhorn Plantain
PLAPAT	*Plantago patagonica*	Indian-wheat
POLALB	*Polychidium albociliatum (= Leptochidium albociliatum)*	
POLALB	*Polygala alba*	White Milkwort
POLAVI	*Polygonum aviculare*	Prostrate Knotweed
POLERE	*Polygonum erectum*	Erect Knotweed
POLTRA	*Polanisia trachysperma*	Clammy-weed
POLYGO	*Polygonum spp.*	Knotweed
POTARG	*Potentilla arguta*	Tall Cinquefoil

FORBS

Code	Scientific Name	Common Name
POTENT	*Potentilla spp.*	Cinquefoil
POTPEN	*Potentilla pensylvanica*	Prairie Cinquefoil
PSOARG	*Psoralea argophylla*	Silver-leaved Scurf-pea
PSOESC	*Psoralea esculenta*	Indian Bread-root
PSOLAN	*Psoralea lanceolata*	Lemon Scurf-pea
PYRSEC	*Pyrola secunda*	One-sided Wintergreen
RATCOL	*Ratibida columnifera*	Prairie Coneflower
RUMVEN	*Rumex venosus*	Wild Begonia
SALKAL	*Salsola kali (= Salsola iberica)*	Russian Thistle
SEDLAN	*Sedum lanceolatum*	Lance-leaved Stonecrop
SENCAN	*Senecio canus*	Woolly Groundsel
SENINT	*Senecio integerrimus*	Western Groundsel
SENPLA	*Senecio plattensis*	Prairie Groundsel
SENSTR	*Senecio streptanthifolius*	Rocky Mountain Butterweed
SILSCO	*Silene scouleri*	Scouler's Silene
SISALT	*Sisymbrium altissimum*	Tumblemustard
SMIHER	*Smilax herbacea*	Carrion-flower
SMIRAC	*Smilacina racemosa*	False Spikenard
SMISTE	*Smilacina stellata*	Starry Solomon-plume
SOLCAN	*Solidago canadensis*	Canada Goldenrod
SOLIDA	*Solidago spp.*	Goldenrod
SOLMIS	*Solidago missouriensis*	Missouri Goldenrod
SOLMOL	*Solidago mollis*	Velvety Goldenrod
SOLMUL	*Solidago multiradiata*	Northern Goldenrod
SOLNAN	*Solidago nana*	Low Goldenrod
SOLNEM	*Solidago nemoralis*	Gray Goldenrod
SONARV	*Sonchus arvensis*	Field Milk-thistle
SPHCOC	*Sphaeralcea coccinea*	Red Globe-mallow
STERUN	*Stephanomeria runcinata*	Runcinate-leaved Skeltonweed
SUAMOQ	*Suaeda moquinii*	Tall Seablite
TAROFF	*Taraxacum officinale*	Common Dandelion
THAOCC	*Thalictrum occidentale*	Western Meadowrue
THAVEN	*Thalictrum venulosum*	Veiny Meadowrue
THERHO	*Thermopsis rhombifolia*	Round-leaved Thermopsis
TOWPAR	*Townsendia parryi*	Parry's Townsendia
TRADUB	*Tragopogon dubius*	Goat's Beard
TRAGOP	*Tragopogon spp.*	Salsify
TRAMIS	*Tragopogon miscellus*	Hybrid Salsify
TRAOCC	*Tradescantia occidentalis*	Prairie Spiderwort
VICAME	*Vicia americana*	American Vetch
VIOLA	*Viola spp.*	Violet
VIONUT	*Viola nuttallii*	Yellow Prairie Violet

FERNS AND FERN ALLIES

EQULAE	*Equisetum laevigatum*	Smooth Scouring Rush
SELDEN	*Selaginella densa*	Compact Selaginella
WOOORE	*Woodsia oregana*	Oregon Woodsia